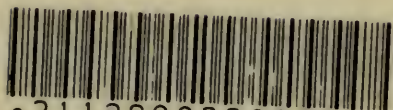
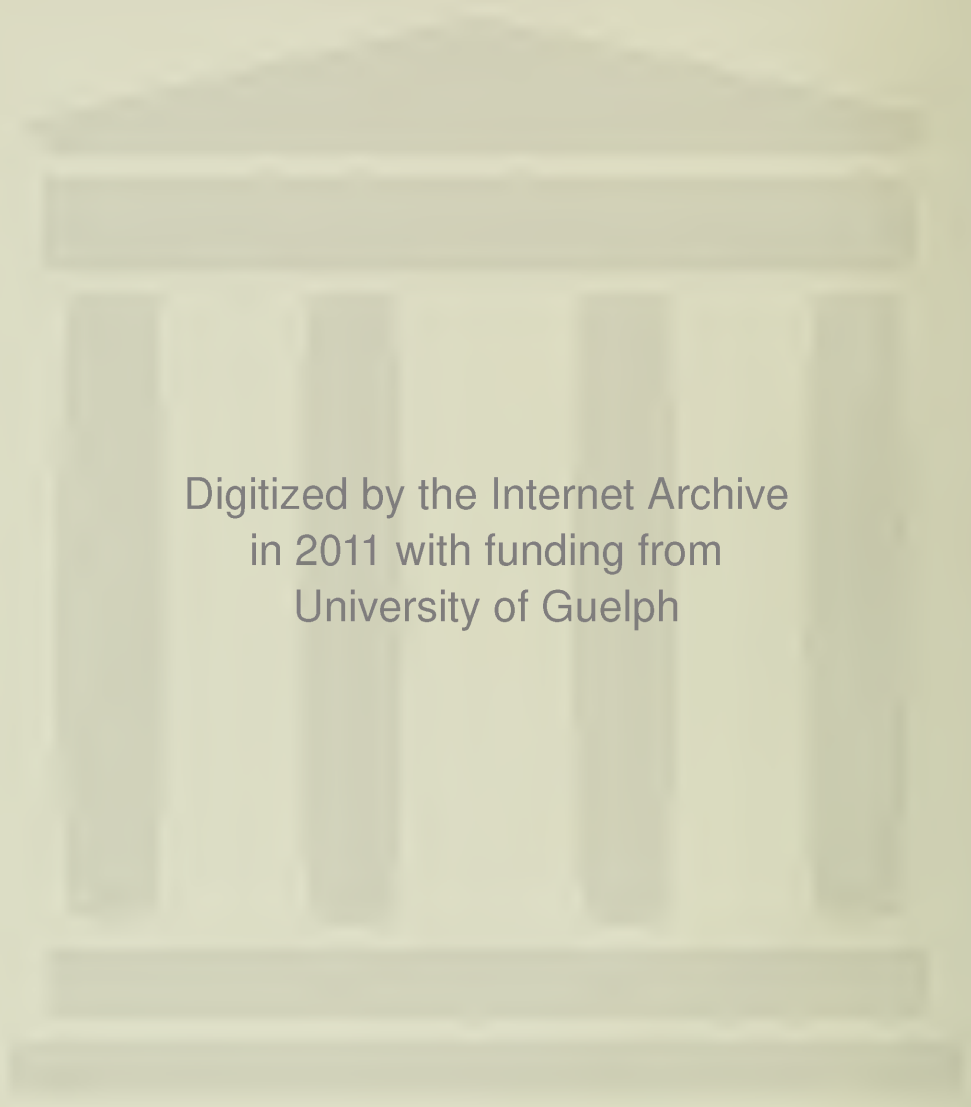


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BULLETINS

Nos. 374 to 396

Issued by the Ontario Department of Agriculture



ONTARIO

TORONTO

Printed and Published by T. E. Bowman, Printer to the King's Most Excellent Majesty
1939

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ISSUED BY

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[MARCH, 1933

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

USE MORE ONTARIO HONEY



Boys Like Honey

By

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USE MORE ONTARIO HONEY

Previous to the introduction of cane sugar from the tropics, honey was by far the most common sweet. (1) In early times the ancients gathered wild honey from hollow trees and crevices in rocks where bees had formed colonies. As civilization progressed and men began to live in tribes, it is probable that bees became more or less domesticated, and were kept in crude hives. Much later, in old England, beekeeping developed into an industry, partly for the honey which was used to sweeten food, and partly for the wax which was used to make candles so extensively in the church. (2).

Since then great changes have taken place, particularly in the 19th century, in the status of honey in the diet, and in the kind of foodstuffs used in most parts of the world. The relatively natural foods used by our ancestors have been largely replaced by highly refined foods which have been robbed in the refining processes of much of the nutritive value which they originally contained. Only recently we have begun to realize the disastrous results of this change, and doctors all over the world are advocating the use of natural foods in preference to highly refined products. Honey is a most desirable natural food, and it would be to our advantage to eat more of this wholesome sweet.

What is Honey?

Honey is the nectar obtained from flowers by worker bees, which after modification in the honey stomach of the latter, is stored in the cells of the comb. (3). Further concentration is effected by evaporation in the hive. (4). Honey belongs to the class of foods known as carbohydrates. It is practically a solution in water of two sugars, dextrose and levulose, in nearly equal proportions with a very small quantity of sucrose (another sugar); it is naturally flavoured and gives off an aroma imparted to it by the flowers from which it is gathered. (3). Since honey is a natural food, it contains certain substances not found in white sugar — that is small amounts of protein and mineral matter. (5). Although these occur in too small quantities to be of great importance in the ordinary mixed diet, they are not to be wholly disregarded.

Honey — Its Wholesomeness and Value as a Food.

Honey is ranked as one of our best fuel or energy producing foods and compares favourably in this respect with bread, potatoes, molasses, jam, etc. Of these the sweet or sugary foods liberate energy for use in the body more quickly than do the starchy foods. In this respect honey is particularly good, since the two principle sugars which are its chief components (mainly dextrose and levulose mentioned above) can be immediately assimilated from the digestive tract without undergoing further digestion. It is a very satisfactory and wholesome foodstuff valuable in the diet of both sick and well persons, and worthy of more extended use than it has had.

Granulated sugar and similar products, when eaten in more than small amounts have a tendency to irritate the digestive tract, often causing gas and indigestion, especially in people who take little exercise. Honey is remarkably free from this fault. (3a). Honey has a slightly laxative effect and for this reason persons suffering from constipation find it a valuable addition to their diet. (3b).

Furthermore honey is a food which is rarely if ever adulterated (3c).

Buying Honey for Home Use

Several forms of honey are found on the market—comb honey, extracted honey and regranulated honey. The latter is a product of recent investigations, (see page 3).

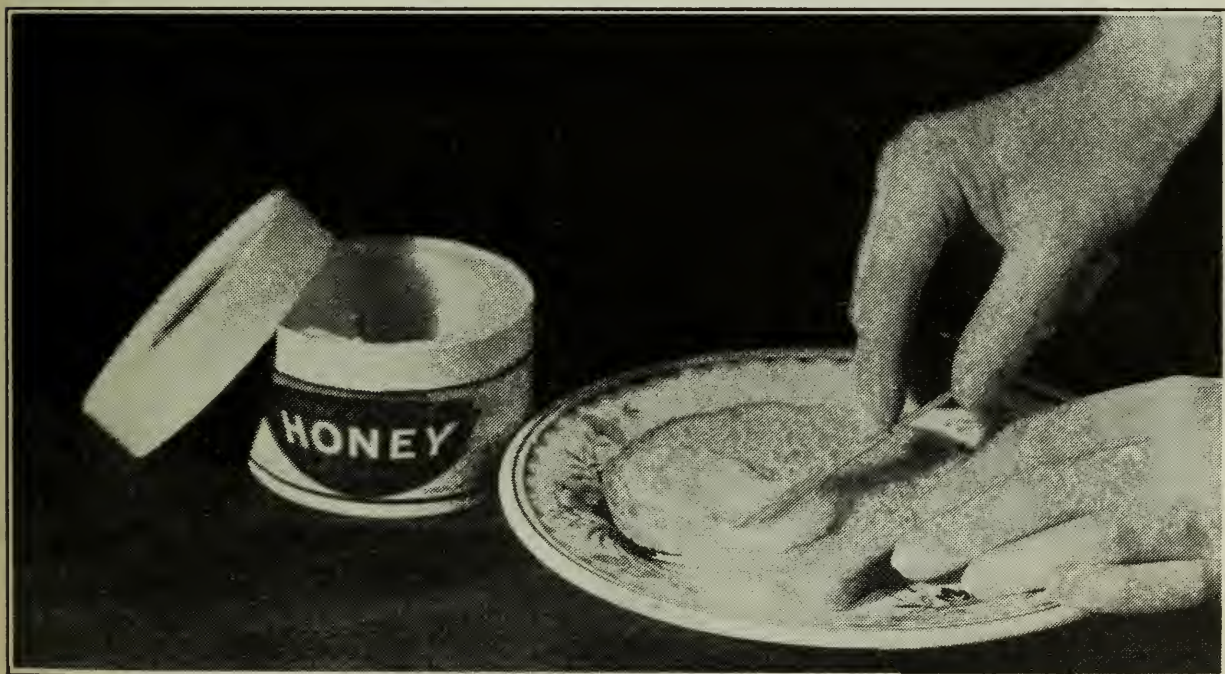
These may appear under various trade names. Honey differs in color and flavour depending on the flowers from which it has been gathered. In this country, the white honeys are obtained chiefly from the clovers, basswood, raspberry and fireweed, the amber honeys from various sources, such as dandelion, fruit bloom, goldenrod, and dark honeys chiefly from the buckwheat. The lighter honeys are more delicately flavoured, the dark ones are stronger in flavour.

Honey in the comb is a fancy article and is an attractive variation, but for general use the extracted honeys are more economical and practical. Extracted honey is the liquid honey which is produced by uncapping the combs and removing the honey from the cells by centrifugal force. Wax particles and other foreign matters are removed by straining the honey through several layers of cheesecloth, then allowing it to stand undisturbed for some time. Wax particles and other ingredients rise to the surface and are skimmed off, and the honey is then put into containers. This is honey as found on the market. (6).

Extracted honey is most commonly packed in glass jars containing from 3 ozs. to 1 lb., or in tins holding 2 lbs. 3 ozs., 4 lbs. 8 ozs. or 9 lbs. 4 ozs., and comb honey is usually sold in sections weighing 12 ozs. to 16 ozs. Honey in tins keeps as well as in glass jars and costs about half as much as it does in glass jars or in sections.

The extracted honeys most commonly produced in Canada begin to crystallize within a few weeks after removal from the hive. This granulation is characteristic of good quality honey. Impure or adulterated honeys do not granulate as readily as do pure honeys. (3d).

†Regranulated, or processed honey as it is sometimes called, is being sold on the market for the first time. It appears under various trade names. It is a product of recent discovery, brought about to meet the great need of a method of treating honey to control fermentation, and yet keep its flavour and have the honey crystallize finely



The new regranulated honey has a fine, smooth, uniform texture. It has lost its drippiness and can be cleanly and conveniently lifted with a spoon or spread with a knife.

† NOTE—The inventor prefers the name “regranulated” rather than “processed,” since the latter is apt to be misleading to the general public.

and have it form a product of smooth and even consistency. It should be clearly understood that this method of treating in no way alters the food value of the honey—nothing is taken from the honey, and no foreign material is added to it. The only difference is in the size of the crystals—but what an improvement this is!

Stated briefly, the process is one of pasteurizing extracted honey at a definite temperature to prevent fermentation and then cooling it rapidly to avoid loss of flavour. About 5% of previously regranulated honey is stirred into the liquid honey after it is cooled. This acts as a starter which promotes rapid granulation so that within a few days at lower temperature, the whole mass takes on a fine, smooth, uniform semi-solid texture. It is safe from fermentation, providing the honey is not left open to the air, and retains its natural delicious flavour. This regranulated honey is most satisfactory for table and kitchen use. It has lost its drippiness and can be cleanly and conveniently lifted with a spoon, or spread with a knife. (7).

Regranulated honey should not be confused with other honeys which have been on the market for several years, and which are sold under trade names which might suggest the regranulated honey described above. These honeys have been treated in an effort to produce fine granulation, but have not been pasteurized and hence are not protected against fermentation, they are not as homogeneous as is the regranulated honey, and they usually have a scum of air bubbles on the top. However, it is probable that this type of honey will shortly be replaced by the more satisfactory regranulated honey.

Although the regranulated honey at present costs slightly more than the ordinary extracted honey, its excellent keeping qualities, the ease with which it may be handled, and its pleasing flavour and texture make it well worth the extra expenditure.



Packages in which honey may be purchased.

Storing Honey in the Home

Owing to the tendency of honey to absorb moisture and to ferment, (the latter does not refer to regranulated honey), it should be kept in a dry place. The kitchen cupboard is likely to be drier than the cellar or refrigerator, and for this reason is recommended as a storage place for honey. (3e). Although regranulated honey does not ferment, there is no advantage gained in keeping it in a refrigerator.

How to Use Honey in Foods

Not only is honey a healthy, wholesome food, but it is, also, a food of most delicious flavour, and is not flavour one of the most important attributes of any food? Honey not only gives food a honey taste, but it may also be used to bring out and intensify food flavours. Honey imports a new tang and flavour to foods.

To many persons the use of honey suggests only limited possibilities. But honey may be used in foods in many ways. As well as being a delicious spread on bread, rolls, and hot tea biscuits, it can be used to advantage in making cookies, cakes, desserts, candies, and preserves. In fact, it can be used in practically every way in which ordinary sugar is used, and is preferable in many ways.

All fruits to which sweetening is added for serving are improved in palatability if honey is substituted for sugar. To use it successfully, care should be taken not to oversweeten. This is easily avoided if the honey is warmed, by placing the honey jar in *warm water*, *not hot*, for sometime before using. It will then pour in tiny threads and gives just the sweetness desired. This is termed "drizzling" honey. (9).



Drizzling honey.

When using honey it cannot be substituted indiscriminately for sugar or molasses in recipes because of the difference in chemical nature. Less soda is required when substituting honey for ordinary molasses, since the amount of acid in honey is less than that in molasses. About one quarter of a teaspoon of soda is sufficient for one cupful of honey.

Honey may be substituted for all or part of the sugar in a recipe. On account of the water in honey, when substituting it for sugar, the liquid in the recipe should be lessened by about one quarter of a cup to each cup of honey used. Keeping these facts in mind, substitution of honey for sugar may be made in any recipe. (8).

Honey is equal to sugar in sweetening power and baked foods made with honey keep moist much longer due to the moisture retaining power of honey. For this reason many bakers use large portions of honey every year. (3f). Why should the housewife not use honey to advantage in home cookery?

The following are recipes which were tested in the Macdonald Institute test laboratories by Miss Dorothy Hewitt, Guelph. (10).

NOTE—On account of the variations in water content of honeys from different sources, it is advisable to test each new pail of honey by making a small recipe first before making the larger amounts. Ontario honey was used in these recipes. It contains about $\frac{1}{4}$ of a cup of liquid to each cup of honey.



A great variety of delicious foods may be made with honey.

BEVERAGES

HONEY ICED COFFEE

Make coffee as usual. For each cup of black coffee allow 1 tablespoon honey and 1 teaspoon cream. Pour hot coffee over cracked ice, add cream blended with honey, chill and serve ice cold.

HONEY ICED CHOCOLATE

2 teaspoons cocoa	1 cup milk
2 tablespoons honey	$\frac{1}{8}$ tsp. salt

Blend cocoa and honey. Heat milk to boiling point, remove from fire and add honey mixture and salt. Stir well, pour on cracked ice and garnish with whipped cream.

HONEY LEMONADE

 $\frac{1}{2}$ lemon

1 tbsp. honey

Blend honey and lemon juice. Pour over cracked ice, fill glass with water, stir and allow to chill. Serve garnished with slices of lemon.

HEALTH COCKTAIL

1 egg

 $\frac{1}{2}$ lemon

1-2 oranges

2 tsps. honey

Beat ingredients together, chill before serving.

ROLLS AND BREAD

PARKER HOUSE ROLLS

1 cake yeast

4 tbsp. melted butter

1 pt. milk, scalded and
cooled

3 pts. sifted flour

1 tsp. salt

2 tsps. honey

Dissolve yeast and honey in lukewarm milk. Add butter and half the flour. Beat until perfectly smooth, cover and let rise in a warm place until double in bulk (about 1 hour). Add sufficient flour to make a dough that can be handled, add salt. Knead well. Place in a greased bowl, cover and let rise until double in bulk. Roll out $\frac{1}{2}$ inch thick, cut with a 3 inch biscuit cutter, crease through centre with a dull edged knife and fold over. Place in a well greased shallow pan, cover and let rise until light (about $\frac{3}{4}$ hour). Bake 10 minutes in a hot oven.

GRAHAM BREAD

1 cake yeast

2 tsps. lard or butter

1 cup milk, scalded and
cooled

melted

4 cups graham flour

4 tsps. honey

1 cup sifted white flour

1 cup lukewarm water

1 tsp. salt

Dissolve yeast in lukewarm liquid, add honey and shortening. Then add flour and salt gradually, until dough is formed that can be handled. Knead thoroughly being sure to keep dough soft. Cover and set aside in a warm place to rise for about $1\frac{1}{2}$ hours. When double in bulk turn out on board and mould into loaves. Place on well greased bread pan, cover and let rise for about $\frac{1}{2}$ hour. Bake 1 hour in a slower oven than for white bread.

BATTERS AND DOUGHS

2 cups flour

2 tsps. baking powder

 $\frac{2}{3}$ cup milk

1 tsp. salt

2 tsps. honey

 $\frac{2}{3}$ tbsp. butter or lard

Sift the dry ingredients, then cut in the fat. Mix honey and milk and add to flour in mixture. Roll out, cut and bake in a hot oven. Serve piping hot with honey.

BASIC MUFFIN BATTER

1 egg

1 cup milk

2 tbsp. butter

2 cups flour

2 tsps. honey

4 tsps. baking powder

1 tsp. salt

Mix and sift flour, baking powder and salt. Beat eggs until foamy and add honey and milk. Melt shortening and turn it into the egg mixture. Turn wet ingredients into dry ones all at one time. Stir vigorously until the dry ingredients are just dampened. Fill muffin tins $\frac{2}{3}$ full and bake in a hot oven for 20 minutes. Serve with honey.

NOTE—Pleasing variations may be made using the basic muffin batter and drop a few cherries into each muffin after it has been poured into muffin tins, or by sprinkling grated cheese over each muffin after it has been poured into the muffin tins.

CORNMEAL CAKE

$\frac{1}{2}$ cup cornmeal	$\frac{1}{2}$ tsp. salt
1 cup flour	$\frac{1}{2}$ cup sour milk
3 tsp. baking powder	$\frac{1}{2}$ tsp. soda
6 tbsp. honey	1 egg
3 tsp. shortening	

Mix flour, baking powder, soda and salt, sift and add cornmeal. Beat egg until light, add honey and sour milk. Melt shortening and turn it into egg mixture. Turn all wet ingredients into dry ones all at one time. Stir vigorously until dry ingredients are just dampened. Fill muffin tins $\frac{2}{3}$ full and bake in a hot oven for 20 minutes.

HONEY OATMEAL GEMS

1 egg	2 tbsps. vegetable shortening
1 cup milk	1 tsp. salt
1 cup oatmeal	$\frac{1}{4}$ cup chopped walnuts
$\frac{1}{4}$ cup honey	4 tsp. baking powder
$1\frac{1}{2}$ cups flour	

Mix flour, salt and baking powder, sift and add oatmeal. Beat egg until foamy, add honey and milk. Measure and melt fat and turn it into egg mixture. Turn all wet ingredients into dry ones all at one time and stir vigorously until dry ingredients are just dampened. Fill muffin tins $\frac{2}{3}$ full and bake in a hot oven 20 min.

HONEY MUFFINS

3 tbsps. honey	$2\frac{1}{4}$ cups graham flour
$\frac{1}{4}$ cup butter	$\frac{1}{2}$ cup white flour
2 eggs	3 tsp. baking powder
$\frac{1}{8}$ tsp. salt	1 cup milk

Mix and sift white flour, baking powder and salt. Add graham flour. Beat eggs until foamy, add honey and milk. Melt butter and turn it into egg mixture. Turn wet ingredients into dry ones all at one time. Stir vigorously until dry ingredients are just dampened. Fill muffin tins $\frac{2}{3}$ full and bake in a hot oven for 20 minutes.

HONEY NUT-BRAN MUFFINS

6 tbsps. honey	1 tbsp. butter
1 cup flour	$1\frac{1}{4}$ cups milk (sour)
$\frac{1}{2}$ tsp. soda	$\frac{1}{4}$ cup chopped walnuts
$\frac{1}{4}$ tsp. salt	1 egg
2 cups bran	

Mix and sift flour, salt and soda, add bran. Beat egg until foamy and add honey and milk. Measure and melt butter and turn it into the egg mixture. Turn all wet ingredients into dry ones all at one time. Stir vigorously until dry ingredients are just dampened. Fill muffin tins $\frac{2}{3}$ full and bake in a hot oven for 20 minutes.

QUICK BREADS

NUT BREAD

$\frac{2}{3}$ cup honey	3 tsps. baking powder
1 egg	$\frac{1}{2}$ tsp. salt
1 cup milk	$\frac{1}{2}$ cup nut meats
3 cups flour	

Beat egg well, blend with honey and milk. Add chopped nut meats. Sift flour, baking powder and salt and add to egg mixture. Pour into greased loaf pan and let stand for one hour. Bake in a slow oven for one hour.

QUICK BREAD WITH HONEY

1 cup graham flour	$\frac{1}{2}$ tsp. salt
1 cup bread flour	1 cup milk
2 tsps. baking powder	$\frac{1}{2}$ cup honey

Mix and sift dry ingredients, add milk and honey and beat well. Pour into a greased bread pan and bake in a moderate oven for one to one and a half hours.

HOT WATER GINGERBREAD

$\frac{1}{4}$ cup butter and lard	$\frac{1}{2}$ tsp. soda
$\frac{1}{2}$ cup honey	$\frac{1}{8}$ tsp. salt
2 eggs	1 $\frac{1}{2}$ tsps. ginger
$\frac{1}{2}$ cup molasses	$\frac{1}{4}$ cup boiling water
1 $\frac{1}{2}$ cups flour	

Cream the butter and lard, add honey slowly, and beaten egg. Mix boiling water with molasses, add alternately with the sifted dry ingredients. Pour into greased pan. Bake in a slow oven for 50 to 60 minutes. Oven temperature 300-325° F.

GRIDDLE CAKES AND WAFFLES

CORN GRIDDLE CAKES

2 cups cornmeal	$\frac{1}{2}$ tsp. salt
$\frac{1}{4}$ cup honey	2 $\frac{1}{2}$ cups milk
1 cup sifted flour	3 tsps. baking powder
2 eggs	2 tbsps. melted butter

Mix, and sift dry ingredients, beat eggs until light, add honey, milk and melted butter. Combine with dry ingredients and bake on a well oiled griddle.

HONEY CREAM WAFFLES

2 cups flour	2 cups milk
1 tsp. salt	$\frac{1}{4}$ cup vegetable shortening
1 egg	3 tbsps. honey
4 tsps. baking powder	

Mix melted shortening, honey, salt and beaten eggs. Sift flour and baking powder and stir alternately into honey mixture with milk until full amount has been added. Bake in hot waffle irons.

FRUITS AND VEGETABLES

BAKED APPLES

Wash, core and place apples in a baking dish in a moderate oven. When apples begin to soften, fill core with honey and sprinkle with lemon juice. Finish baking.

PRUNE WHIP

1 egg white	$\frac{1}{8}$ tsp. salt
2 tbsps. honey	8 cooked prunes

Puree prunes. Beat egg white until stiff, then gradually beat in honey, add salt and prune pulp. Chill and serve with boiled honey custard.

STEWED RHUBARB

Wipe and cut stalks in $\frac{1}{2}$ inch pieces. To each cup of fruit add $\frac{1}{2}$ cup honey. Let simmer until tender. If rhubarb is allowed to stand in boiling water for 5 minutes, drained and then cooked, less sugar will be needed.

HONEY NAVY BEANS

1 onion	2 tbsps. cooking oil
$\frac{1}{4}$ lb. bacon	2 tbsps. honey
2 tbsps. butter	2 apples

Soak beans in cold water, overnight, drain. Place onion, bacon and butter in bottom of bean pot, add beans. Mix oil and honey and pour over the beans. Lay sliced apples over beans to cover them, keep moist while baking, add pepper and salt to taste, bake well.

PRESERVES, JELLY, JAMS, MARMALADE

PRESERVED CHERRIES

Pick over, wash, stem and pit cherries. Pack in sterilized jars. Make a syrup of two parts water or fruit juice to 3 parts honey. Allow to boil for one minute then pour over cherries, filling jars to within $\frac{1}{2}$ inch of top of jars. Put on rubbers and tops and partly tighten. Place in sterilizer, being sure that the water covers the tops of the jars. Sterilize for 16 minutes, remove from water, tighten tops and place on a cloth, upside down for several hours. Protect from drafts.

APPLE GINGER

Wipe, pare, core, quarter and finely chop sour apples. There should be 10 cups. Put in a preserving kettle and gradually bring to the boiling point. Add 2 cups of honey and thin shavings of rind of 2 lemons and a 2 inch piece of ginger root. Simmer, stirring frequently until the apples are transparent ($2\frac{1}{2}$ —3 hrs). Great care must be taken during cooking, otherwise mixture will burn very easily. Turn into sterile jelly tumblers.

RASPBERRY JAM

Pick over berries, mash a few in the bottom of a preserving kettle, using a wooden potato masher and so continue until all the fruit has been used. Heat gradually to the boiling point and simmer for 30 minutes. Add gradually an equal quantity of honey and let simmer for 15-20 minutes. Put in tumblers.

RHUBARB CONSERVE

4 lbs. rhubarb	1 lb. seeded raisins
5 lbs. honey	2 oranges
1 lemon	

Wash and peel stalks of rhubarb and cut in one inch pieces. Put in a preserving kettle and add honey, raisins and grated rind and juice of oranges and lemons. Mix, cover and let stand $\frac{1}{2}$ hour. Place on stove, bring to boiling point and let simmer for 45 minutes, stirring almost constantly. Fill jelly glasses with mixture, cool and seal.

APPLE MARMALADE

Use tart apples. Wipe, peel, core and cut in small pieces. Cook until smooth. Add one pound honey to two pounds fruit and simmer until mixture has the consistency of cake batter. Put into glasses without sealing, in a few weeks it may be cut out.

SALADS AND SALAD DRESSINGS

FRUIT SALAD DRESSING

$\frac{1}{4}$ cup honey	2 tbsps. olive oil
3 tbsps. lemon juice	$\frac{1}{2}$ tsp. paprika

Mix honey, lemon juice, olive oil and paprika, beat well or shake in a jar. Chill. This is an excellent dressing to blend fruits in a fruit salad and is, also, good over shredded cabbage.

MAYONNAISE

2 egg yolks	$1\frac{1}{2}$ cups oil
2 tbsps. honey	4 tbsps. lemon juice or weak
1 tsp. salt	vinegar

Beat together the egg yolks, honey and salt. Add a few drops of oil at a time, beating constantly until the oil is all added. Thin down to desired consistency with lemon juice.

HONEY FRUIT SALAD

Cut up oranges, bananas, apples or any combination of fresh fruits desired. Arrange in clusters on bed of lettuce. Drizzle with honey. Serve with whipped cream or dressing.

STUFFED APPLE SALAD

Take an apple for each salad, pare and remove all the seed cavities from the centre. For 6 apples make a syrup of 1 cup water and 1 cup honey, add a speck of red colour paste and the juice and grated rind of a lemon or an orange. In this syrup, cook the apples until tender, turning as needed to keep them whole. Let cool in the liquid. To serve, set in a bed of shredded lettuce. Fill the centres with the following salad dressing. Garnish with pecan nut meats and halves of pears.

SALAD DRESSING FOR STUFFED APPLE SALAD

2 tsps. flour	1 tbsp. vinegar
$\frac{1}{4}$ cup honey	1 lemon
$\frac{1}{4}$ tsp. salt	1 egg
$\frac{1}{2}$ cup cream cheese	$\frac{1}{2}$ cup cream

Blend flour, salt and honey. Heat vinegar and lemon juice over hot water, blend with flour mixture and cook in a double boiler. Stir. Beat egg, add flour mixture and return to double boiler. Stir until egg is well cooked. When cool, gradually beat in the cream cheese (pressed through a seive). Then fold in a cream whipped until stiff.

PIES

PLAIN PASTRY

$1\frac{1}{2}$ c. pastry flour	$\frac{1}{2}$ c. fat
$\frac{1}{4}$ tsp. salt	cold water

Sift flour and salt. Cut in one-half the fat, and add cold water to make a stiff dough. Roll in a thin sheet, and spread remaining fat on one-half the dough. Fold, pat and roll out; repeat. This amount is sufficient for two shells.

LEMON PIE FILLING

3 eggs	1 tsp. melted butter
$\frac{1}{2}$ cup honey	1 $\frac{1}{4}$ cups rich milk
1 tsp. flour	lemon juice
$\frac{1}{4}$ lemon	

Blend flour, lemon juice, grated rind and butter. Scald milk and add gradually to flour mixture, stirring constantly. Cook over hot water until all trace of raw starch has disappeared. Add honey. Beat egg yolks well and gradually add flour mixture stirring constantly, and return to double boiler. Stir until egg is cooked. Pour this filling into a previously baked pie crust, cover with meringue made from egg white beaten with 2 tbsps. honey, brown in oven.

CHOCOLATE PIE FILLING

2 eggs	$\frac{1}{2}$ tsp. cornstarch
$\frac{1}{2}$ cup honey	1 tbsp. butter
2 tbsps. grated chocolate	1 cup milk
1 tsp. vanilla	

Blend cornstarch with some cold milk, heat remaining milk and add cornstarch mixture. Add chocolate and cook over hot water until all trace of raw starch has disappeared. Beat one whole egg and yolk of other, blend with honey. Add cornstarch mixture and heat until egg is cooked. Add butter and vanilla. Pour this filling into a previously baked pie shell, cover with a meringue made from egg white beaten with 2 tbsp. honey, brown in oven.

BLUEBERRY PIE

2 tbsps. flour	$\frac{1}{2}$ cup honey
2 $\frac{1}{2}$ cups blueberries	$\frac{1}{8}$ tsp. salt
few drops lemon juice	

Line a deep pie plate with paste, fill with berries slightly dredged with flour and salt. Drizzle with honey, cover with pie-paste and bake in a moderate oven. Strawberries, Raspberries, Apples and Cherries may be substituted for above fruits.

DESSERTS

HONEY DATE PUDDING

2 cups dates	$\frac{1}{2}$ cup flour
$\frac{1}{2}$ cup chopped nuts	1 tsp. baking powder
2 eggs	$\frac{1}{2}$ cup bran
$\frac{3}{4}$ cup honey	

Stone and chop dates, chop nuts. Beat eggs until light, add honey and bran. Sift flour and baking powder and add to egg mixture, add fruit and nuts and mix well. Pour into buttered baking dish and bake 20 minutes in a moderate oven. Serve with cream.

JUNKET

1 pt. warm milk	$\frac{1}{2}$ junket tablet
2 tbsps. honey	flavour to taste

Dissolve junket in 1 tsp. cold water, combine milk and honey and add junket tablet. Stir only slightly, allow to set without moving in a warm place, chill and serve.

HONEY CORNSTARCH PUDDING

$\frac{3}{4}$ tbsp. honey	$1\frac{1}{2}$ tbsps. cornstarch
$\frac{1}{8}$ tsp. salt	1 cup scalded milk

Mix honey, salt and cornstarch, combine with hot milk, stirring until smooth. Cook and stir over hot water until mixture thickens. Cover and cook 15 minutes, turn into a mold, chill and serve with cream and sugar.

HONEY TAPIOCA

2 tbsps. tapioca	2 tbsps. honey
1 cup milk	$\frac{1}{4}$ tsp. salt
2 eggs	1 tsp. vanilla

Cook tapioca in milk in a double boiler, add yolks of eggs beaten well and sweetened with honey, add salt and stir until thick, then add beaten egg whites. Remove from fire, cool, stir in vanilla. Serve cold.

HONEY MERINGUE

3 egg whites	$\frac{3}{4}$ cup honey
$\frac{1}{8}$ tsp. salt	

Beat eggs stiff, gradually add honey and salt beating continuously until the mixture peaks. No cooking is required. Use as a garnish for pies, puddings, or desserts. Retains gloss if kept on plate in refrigerator.

GELATINE AND FROZEN DESSERTS

LEMON JELLY

2 tbsps. gelatine	1 cup honey
$\frac{1}{2}$ cup cold water	$\frac{1}{2}$ cup lemon juice
$1\frac{3}{4}$ cups boiling water	grated lemond rind

Boil water with lemond rind. Soak gelatine in cold water and dissolve in boiling water. Add honey, allow to cool and add lemon juice. Strain, pour into jelly molds, chill.

ICE CREAM

4 cups thin cream	$\frac{3}{4}$ cup honey
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Add honey to cream and allow it to stand to blend. Turn into mold and pack in 2 parts ice and 1 part salt. Freeze.

SAUCE FOR ICE CREAM

1 tbsps. butter	$\frac{1}{2}$ cup honey
2 tps. cornstarch	

Cook cornstarch and butter carefully, being careful not to burn them. Add honey and cook the mixture until a hard ball forms in cold water and until all taste of raw starch has disappeared.

HONEY PARFAIT

1 pt. scalded milk	1 cup honey
yolks of 6 eggs	1 pt. cream

Blend egg yolks and honey, allow to stand and cool. Add milk. Heat cream until stiff and add to mixture. Pack in 2 parts ice and 1 part salt and freeze.

ORANGE CHARLOTTE

3 tsps. gelatine	1 lemon
$\frac{1}{4}$ cup cold water	1 cup orange juice
$\frac{1}{2}$ cup boiling water	3 egg whites
1 cup honey	lady fingers or sponge cake

Soak gelatine in cold water and dissolve in hot water, add honey, lemon and orange juice, when partially set beat until foamy and fold in stiffly beaten egg whites. Pour into mold lined with lady fingers or sponge cake cut in strips. Chill and serve.

CAKES, COOKIES AND SMALL CAKES

SOUR MILK SPICE CAKE

$\frac{1}{4}$ cup butter	$\frac{1}{2}$ tsp. soda
6 tbsps. sugar	2 tsps. baking powder
$\frac{1}{4}$ cup honey	$\frac{1}{4}$ tsp. cinnamon
$\frac{1}{2}$ cup sour milk	$\frac{1}{4}$ tsp. cloves
1 egg	$\frac{1}{8}$ tsp. nutmeg
$\frac{2}{3}$ cups flour	$\frac{1}{8}$ tsp. salt

Cream butter, add sugar and egg well beaten. Sift dry ingredients and add to egg mixture, add honey and bake in a moderate oven.

SOUR MILK CAKE

$\frac{1}{4}$ cup butter	$\frac{1}{2}$ tsp. soda
6 tbsps. sugar	2 tsps. baking powder
$\frac{1}{4}$ cup honey	$\frac{1}{8}$ tsp. salt
$\frac{1}{2}$ cup sour milk	$\frac{1}{2}$ tsp. vanilla
1 - $\frac{2}{3}$ cups flour	

Cream butter, add sugar and well beaten egg. Sift dry ingredients and add to egg mixture. Add honey and bake in a moderate oven.

CREAM COOKIES

$\frac{1}{2}$ cup sugar	$\frac{1}{2}$ tsp. soda
$\frac{1}{4}$ cup honey	$\frac{1}{2}$ tsp. baking powder
$\frac{1}{3}$ cup butter	$\frac{1}{16}$ tsp. salt
1 egg	$\frac{1}{4}$ tsp. vanilla
$\frac{1}{2}$ cup sour cream	flour to roll out (about 3 cups)

Cream the butter, add sugar, honey and well beaten egg. Sift flour, soda, baking powder and salt. Add to egg mixture and add sufficient flour to roll out. Cook on greased tins in slow oven.

OATMEAL COOKIES

$\frac{1}{2}$ cup honey	$\frac{1}{2}$ cup raisins
1 cup sugar	3 cups rolled oats
1 cup lard or butter	2 eggs
$\frac{1}{2}$ cup milk	2 tsps. cream of tartar
$\frac{1}{2}$ tsp. salt	1 tsp. cinnamon
1 tsp. soda	flour to roll out (about 2 cups)

Cream butter and add sugar, honey, milk and well beaten eggs. Add slightly floured fruit. Sift flour, salt, cream of tartar, soda and cinnamon. Add rolled oats. Mix and roll $\frac{1}{2}$ inch thick. Bake on a greased pan in a moderate oven.

LEMON SNAPS

2 cups honey	juice of 1 lemon
$\frac{1}{2}$ cup sugar	$\frac{1}{8}$ tsp. nutmeg
$\frac{3}{4}$ cup butter	4 cups flour

Cream butter, add lemon juice, honey and sugar. Beat well. Add flour and nutmeg. Make a dough that will roll out. Cut and place on a buttered sheet and bake in a moderate oven.

COCOANUT MACAROONS

1 egg white	1 cup shredded cocoanut
$\frac{1}{4}$ cup honey	$\frac{1}{8}$ tsp. salt

Beat egg white until stiff, gradually add honey, beating constantly and continue to beat until mixture peaks. Fold in slightly salted cocoanut. Drop from a spoon on a well greased sheet, bake in moderate oven until golden brown.

HONEY NUT RAISIN AND CELERY SANDWICH

Put nuts, raisins and celery through the meat grinder, blend with honey and mayonnaise.

PEANUT RAISIN AND CELERY SANDWICH

Blend honey with peanut butter, add mayonnaise if desired.

HONEY COTTAGE CHEESE AND DATES

Put dates through meat grinder, blend with honey and cheese.

HONEY TOAST

Spread slices of toast with butter, drizzle with honey or spread with comb honey.

HONEY NUT TOAST

Spread slices of toast with honey and sprinkle with chopped nuts.

NUT BREAD TOAST

Place thin slice of nut bread on a shallow pan and oven, toast on both sides. Spread with butter and honey, cut in triangles and serve open face.

CANDIES

HONEY FUDGE

$\frac{1}{3}$ cup honey	$\frac{1}{3}$ cup water
2 cups sugar	2 egg whites
1 tsp. vanilla	

Boil honey, sugar and water until syrup forms a thread when dropped from a spoon. Pour syrup over well beaten whites of eggs, beating continually and until the mixture thickens, add flavouring after mixture has partially set. Drop in small pieces on buttered or paraffin paper.

HONEY CARAMELS

2 cups sugar	$\frac{1}{4}$ cup honey
$\frac{1}{2}$ cup cream or rich milk	$\frac{1}{4}$ cup butter

Mix ingredients, heat and stir until the sugar has dissolved. Then cook until the mixture forms a soft ball when dropped in cold water. Beat mixture until thick, pour on buttered pan and cut in squares. (10).

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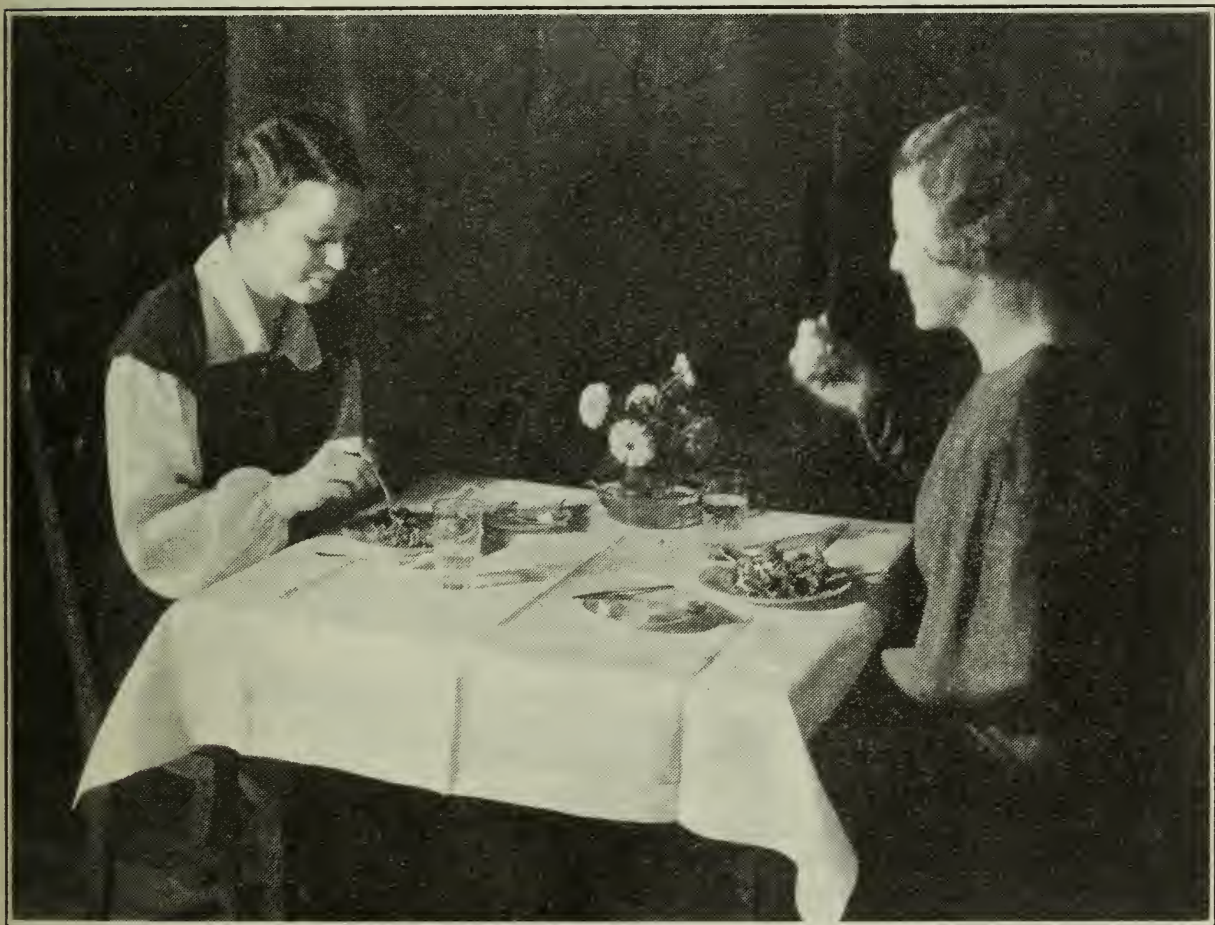
Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Ontario Grown Leaf Lettuce

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Do you know that leaf lettuce—the kind grown right here in Ontario the year round—is higher in minerals and vitamins than the imported head lettuce?

Are you aware of the fact that thousands of dollars are being draughted from Ontario every year, by the foreign lettuce trade? During the fiscal year 1931 the value of lettuce imported via the province of Ontario was \$453,766. (1)

Did you ever stop to consider that in buying this so-called iceberg lettuce, you are paying for a railroad haul of 2,000 miles or more, and that in the end you are getting a product which is lower in food value than the less expensive home grown leaf lettuce?

These are questions of vital interest to every Ontario housewife. Homemakers of today more than ever before, realize their responsibility as intelligent consumers—they wish to spend their food money to the best advantage and they realize that food value as well as cost must

enter into consideration. The home market is needed today for Ontario grown leaf lettuce as well as for other home grown and Empire products. Ontario leaf lettuce is superior in food value to the iceberg lettuce which fact alone should carry sufficient weight in favour of its use, especially as the importance of the diet with relation to health is so widely recognized. Doctors and scientists the world over are urging us to choose our food wisely. This places a great responsibility upon the homemaker, and it is therefore essential for her to find out all she can about the value of the common foodstuffs and what place to give each in the diet.

SPECIFICATIONS FOR FOOD ECONOMY IN AN ADEQUATE DIET

The tendency of the average family is to spend too little for fresh vegetables and fruits and for milk and milk products. These foods are called the "protective" foods as liberal amounts of them included in the diet will insure against mineral and vitamin deficiency. As a guide for an adequate diet for the family of average means, it has been recommended that the food money be divided into fifths (2):—

"one fifth, more or less, for vegetables and fruits;
one fifth, or more, for milk and cheese;
one fifth, or less, for meats, fish and eggs;
one fifth, or more, for bread and cereals;
one fifth, or less, for fats, sugar and other groceries."

Building bodies and keeping them in good condition is somewhat like building engines and keeping them in good running order. First of all one must know what is required and then one must know where these requirements may be obtained.

(a) *Fuel* is required for the human engine. This is supplied by food. A pound of starch as found in cereals, or a pound of sugar, yields the same amount of energy when burned in the body as does a pound of protein—such as found in abundance in milk, meat, eggs and cheese. A pound of fat yields over twice as much energy as a pound of starch or protein. The unit of measure for the energy produced is the calorie—just as the foot is a unit of measure for length. The cheapest source of fuel is probably some form of cereal which is rich in starch. Sugar is cheap but too much sugar or too much fat causes indigestion.

(b) To build the human machine and to keep it in good running order, *building and repair parts* are necessary. These are supplied by the proteins in our foods, and proteins of good quality such as found in meat, milk, eggs and cheese, should be included every day in the diet.

(c) *Minerals*—lime, phosphorus, iron and iodine—are regulators needed by the human engine. These are obtained chiefly from fresh vegetables and fruits and from milk and milk products. Milk is especially important to protect the body against lime deficiency.

(d) *Vitamins—A B C D and E*, might be compared to the spark which is necessary to ignite the gasoline in a car. In the human machine the vitamins govern the behaviour of the fuel and repair foods. The chief source of supply of these vitamins is the same as for the minerals—fresh vegetables and fruits and milk and milk products.

(e) Just as with the engine—care must be taken to administer these supplies properly. Cook food properly so that it will be appetizing and digestible and so as to preserve as far as possible the nutritious elements in it. *Choose your food wisely, including every day some foods from each of the five groups mentioned in the budget above.* Be sure that your food combinations are appetizing and digestible. Include plenty of bulky foods such as fruits, vegetables, and whole grain cereals in the

diet to promote proper elimination of waste materials from the human machine.



For better health, use more vegetables and fruits. Eat at least two vegetables besides potatoes each day. Ontario grown leaf lettuce is an excellent vegetable to include.

WHAT VALUE LEAF LETTUCE?

Which of these necessities of life does lettuce supply to the body? Lettuce is a leafy vegetable, high in vitamin and mineral content. It is for the vitamin and mineral content that we value lettuce—the protein and energy requirements in the diet may be obtained from other foods. It is interesting to note that in the instances where the leaf and head lettuce have been tested experimentally, leaf lettuce is superior to head lettuce of the iceberg type.

Leaf lettuce is valuable for the iron which it contains and it has been shown that the diets of many Canadians are low in iron (3). Unless sufficient iron is supplied in the food, an anemic condition results, varying in its intensity with the relative lack of iron in the food. Fatigue nearly always accompanies an anemic condition, however slight it may be (4). For best health it is important that our daily food supply us with plenty of iron. Leaf lettuce contains over four times as much iron as does head lettuce (5). It has been noted that vegetables containing little green coloring matter, such as cabbage, celery and head lettuce, are comparatively low in iron, and since it has been found that green leafy lettuce is so much richer in iron than the whiter head lettuce, it would seem logical to draw the conclusion that the greener the leaf, the greater the amount of iron which it contains.

IRON CONTENT OF LEAF LETTUCE vs HEAD LETTUCE

Leaf Lettuce

Head Lettuce

*One Serving (Approximately 30 gms) of:-
Leaf Lettuce Contains .56 mgms of IRON
Head Lettuce Contains .13 mgms of IRON*

Lettuce is an important food article because of its vitamin content. Vitamins are substances in food which are necessary for proper nutrition. The minute traces of these substances present are most spectacular in their effect on health. As with minerals, our dietaries are very apt to be lacking in one or more of the vitamins, especially in the winter and spring months, resulting in a marked effect on our well being. Perhaps the reason for our diets being low in vitamins is the fact that many of us are ignorant of the distribution of the vitamins.

VITAMIN VALUES of some of the common FRUITS AND VEGETABLES

Taken from the Chemistry of Food and Nutrition by Henry C. Sherman.

- * indicates that the food contains the vitamin.
- ** indicates that the food is a good source of the vitamin.
- *** indicates that the food is an excellent source of the vitamin.
- indicates that the food contains no appreciable amount of the vitamin.
- ? indicates doubt as to presence or relative amount.
- § indicates that evidence is lacking or appears insufficient.

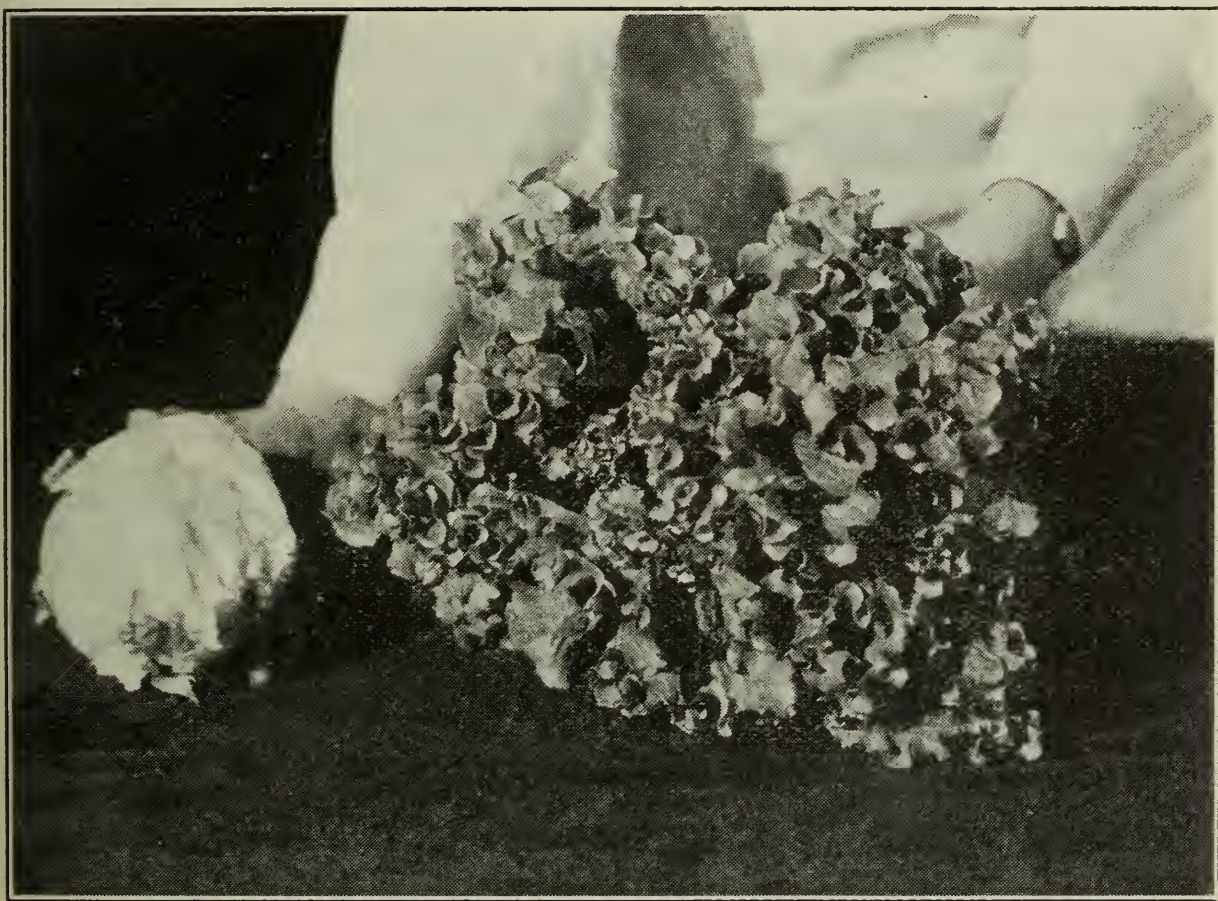
Food	Vitamin A	Vitamin B ₁	Vitamin B ₂	Vitamin C
Spinach, raw	***	**	**	***
Cress	***	**	**	***
Tomato, raw or canned	**	**	**	***
Carrots, fresh, young	***	**	**	**
LETTUCE	* to **	**	**	***
Cabbage, raw	*	**	**	***
Carrots, old, raw	***	**	**	*
Potatoes	*	**	**	**
Apples	*	* to **	**	**
Cabbage, cooked	*	**	**	*
Cauliflower	*	**	**	*
Rutabagas	— to *	**	§	***?
Corn, yellow	**	**	*	—
Pears	§	**	**	*
Peaches, raw	* to **	* to **	§	**
Strawberries	*	*	§	***
Grapes	*	* to **	§	*
Onions, cooked	— to *	*	*	*
Celery, bleached stems	— to *	**	§	§

IT WILL BE NOTED THAT LETTUCE COMES WELL TO THE FORE IN VITAMIN VALUE

Vitamin A—is primarily associated with growth. It is necessary for the maintenance of health, resistance to disease, and normal length of life. Green leaves are rich sources of Vitamin A, ranking next to butter, milk and eggs. The ultimate source of vitamin A is the green plant, and experiments show that the greener the leaf, the more vitamin A is present in the leaf (6) (7) (8). It has been definitely shown by experiment that leaf lettuce is a much richer source of vitamin A than head lettuce of the iceberg type, and strongly suggests that there is a very close relationship between the greenness of plant tissue and the vitamin A content (9).

Vitamin B—is made up of at least two parts, namely B_1 and B_2 .

Vitamin B₁—is necessary for maintenance of a healthy condition of the digestive tract. Lack of normal appetite, loss in body weight, and functional disturbances of the digestive tract accompany vitamin B_1 deficiency. The vegetables which are richest in vitamin B_1 are spinach tomatoes, asparagus, celery, lettuce and cabbage (10).



Green leafy lettuce is much higher in minerals and vitamins than pale, blanched head lettuce.

Vitamin B₂—is necessary to prevent against gastro intestinal disturbances, skin lesions and tendencies to changes in the nervous system. Spinach, lettuce and cabbage have been shown to be valuable sources of vitamin B_2 . It is thought the darker green leaves contain more of this vitamin than paler leaves (11).

Vitamin C—For a healthy condition of the teeth, gums, blood, joints, and for general well-being, vitamin C is essential. Lettuce is a good source of vitamin C. (10).

Vitamin E—is necessary for the maintenance of normal reproductive functions. It is interesting that fresh green lettuce is one of the most potent sources of vitamin E. (10).

From the above it is quite evident that leaf lettuce is an excellent source of iron and of the vitamin A, B₁, B₂, C and E, and in practically every case quite superior to the head lettuce. Leaf lettuce then should occupy an important place in our dietaries, for lettuce is a valuable food product,—the greener the leaf, the more valuable it is. Since the value of lettuce as a food has become so generally known, no longer is it polite to leave lettuce on one's salad plate.

Lettuce is, also, valued for the bulk which it supplies which accounts for its laxative properties. Using liberal amounts of Ontario grown leaf lettuce every day will do a great deal toward solving the problem of getting a sufficiently bulky diet to promote proper elimination and a healthy digestive tract.

Increasing the consumption of leaf lettuce will be of advantage to us economically, for not only do we pay less for home-grown leaf lettuce than for iceberg lettuce but the returns for the smaller output of money are greater when considered from the standpoint of nutritive value, and our diets should be considered chiefly from the nutritive standpoint.

SELECTION OF LETTUCE

The consumer should be able to recognize quality in lettuce when purchasing it. Choose the freshest lettuce obtainable, rather than that which has been held in the store a week or more, if it is desired to keep the lettuce in the home for several days.

The age of lettuce is usually indicated by the trim of the butt end of the stem. The butt end of the stem of fresh lettuce is clear, not darkened to any extent, and free from rot; older lettuce is indicated by shortness of stem, presence of ends of leaves that have rotted and been removed, and by rot itself. If the stem has commenced to rot, or if there is even a little slimy green rot on any of the leaves, the flavour is apt to be slightly affected. Do not buy lettuce with dark green spots at the edge or in the main part of the leaf, since this soon spreads to the rest of the leaf. Buy the size of bunch of lettuce best suited to use.

STORAGE AND CARE IN THE HOME

One of the main problems which confronts the housewife is the proper handling and storage of leaf lettuce in the home. It may be necessary to keep the lettuce for a few days only, or it may be desired to keep it for a week or more. A cool cellar, an ice refrigerator or a mechanical refrigerator may be at one's disposal. With proper methods of storing, leaf lettuce will keep in good condition in a cool cellar or a cool room from four to six days or longer, depending on the temperature of the storage place. The homemaker who observes the following rules for the care of lettuce will find that leaf lettuce is very satisfactory in its keeping qualities.

Several methods of storage may be used:—

1. Refrigerator pan, which is a pan with a lid which has small holes in the top for ventilation.
2. An earthenware crock or bowl or a granite dish or granite saucepan with cover.
3. A wrapping of wet paper.
4. A wrapping of dampened cloth.

Note—If the place of storage is very dry, a wrapping of dry-news-paper around the wrapping of damp cloth or paper will prevent rapid drying out.

For short periods of storage from 2 to 3 days, lettuce may be broken from the stem, washed thoroughly, only partially dried with a clean towel and stored in any one of the above mentioned ways in a cool place. It is then ready for use when needed for the table.

If it is desired to keep the leaf lettuce for a week or more, it is advisable to always store it in the bunch, in any one of the methods mentioned above. If the place of storage is not very cool, it is best to store the lettuce in the bunch unwashed, sprinkling sparingly with water if it seems too dry and tending to wilt. However, if the place of storage is cool, the bunches of lettuce may be washed before storing, using plenty of water in the pan so as to avoid crushing the leaves, or if running water is available, by holding each bunch upside down under the tap. Each bunch should then be gently shaken and placed in a clean dry cloth to remove the surplus water.

In any case when lettuce is stored in the bunch, the stem end should be well trimmed, since presence of old leaves and stems of leaves hastens rotting. After using the lettuce each day and before storing again, trim off all stem ends of leaves which have been used. If the lettuce is to be kept for a week or more, without being used in the meantime, it is advisable to remove the bunches of lettuce from storage, trimming the ends and removing any leaves that may have commenced to rot, every three or four days. The lettuce keeps much better if the stem end is kept clean.

Buy Ontario Grown Leaf Lettuce—you will receive greater returns for your money and you will be helping to build up the home market. Home grown leaf lettuce is less expensive and more nutritious than the imported head lettuce—REMEMBER—the greener the leaf the greater the food value.



Buy Ontario grown leaf lettuce.

LETTUCE DISHES

The use of lettuce in salads is familiar to everyone, but the fact that lettuce can also be used in cookery as a basis for many delicious dishes is one with which most people are unfamiliar.

Following are recipes, which we have tested in Macdonald Institute test laboratories, for use of leaf lettuce:—

1. *As a basis for a salad*, use the smaller inner leaves, or if the leaves are very large, the lettuce may be arranged more attractively by cutting out the coarse stem part and then arranging the leaf in a circle. The centre part may be reserved for greens or chopped and served with sugar and vinegar. If as much care is used in arranging the leaf lettuce as in forming the cup with a leaf of iceberg lettuce an attractive lettuce arrangement results. Leaf lettuce may be used as a basis for all kinds of fruit, vegetable or meat salads. The lettuce must of course be crisp, washed and surface moisture removed by patting gently with a clean dry cloth.

2. *Chopped lettuce with vinegar and sugar*—this is one of the oldest known ways of serving lettuce. Shread lettuce. Add finely chopped mint or onion or onion juice only. Season with salt and pepper. Heat together equal parts of vinegar and sugar until the sugar is dissolved, *cool*; then add to the shredded lettuce. Serve immediately. The larger leaves of the leaf lettuce may be served in this form, while the inner leaves may be reserved for the salad basis. This may be served in a bowl or surplus vinegar may be drained off and lettuce served on individual plates. Garnish with hard cooked egg or cucumber or parsley or tomatoes and mayonnaise or boiled dressing. The shredded lettuce may be placed in a bowl and covered with a French dressing instead of the sugar and vinegar mixture. Garnish with hard cooked egg, etc.

3. *Tomato stuffed with chopped lettuce*—Shread and chop lettuce finely, marinate ** in equal parts of vinegar and salad oil, salt and pepper.

** The word marinate, as used in cookery, means to add salt, pepper, oil and vinegar to a salad ingredient or mixture and let stand until well seasoned.

Add a little finely chopped celery. Remove core and centres from firm tomatoes. Fill with chopped lettuce and celery. Garnish with celery tips, cucumber or parsley, serve with mayonnaise or boiled dressing.

4. *Vegetable salad*—carrot, green pea, lettuce and cucumber. Cut raw carrot in $\frac{1}{4}$ " cubes. Cook until tender, drain, cool, and marinate with salt. Cook green peas until tender, drain, cool and marinate. Shread and chop lettuce finely, marinate. Arrange equal amounts of carrots, peas, and chopped lettuce on lettuce leaves. Separate lettuce and peas with fine slices of cucumber. Serve immediately with mayonnaise or boiled dressing.

5. *Jellied lettuce, pea and pimento salad.*

- 1 tbsp. gelatine
- 2 tbsp. cold water
- 1 cup boiling water
- $\frac{1}{4}$ cup boiling vinegar
- $\frac{1}{4}$ cup sugar
- $\frac{1}{2}$ tsp. salt
- $\frac{3}{4}$ cup canned peas
- 1 cup finely shredded and chopped leaf lettuce
- 1 tsp. finely chopped pimento

Make a syrup of boiling water, vinegar and sugar 3 minutes. Soften gelatine in cold water. Dissolve in the hot syrup. Strain into a bowl, set away to partially set. When partially set, add peas, chopped lettuce and pimento. Turn into moistened moulds, chill. Serve on lettuce leaves with mayonnaise or boiled dressing.

6. *Chopped lettuce and egg salad*—Chop leaf lettuce, finely. Marinate, with oil, vinegar, salt and pepper. Arrange piles of marinated lettuce on lettuce leaves. Garnish with hard cooked eggs cut in wedged shaped pieces. Serve immediately with boiled dressing or mayonnaise.

7. *Potato and lettuce salad.*

- 5 boiled potatoes
- 1 tbsp. finely chopped parsley
- $\frac{1}{2}$ c. finely chopped celery
- 1 tsp. onion juice
- 1 c. finely shredded and chopped lettuce
- $\frac{1}{4}$ tsp. celery seed
- 1 tsp. finely chopped pimento
- $\frac{1}{4}$ c. boiled dressing
- $\frac{1}{4}$ c. mayonnaise
- salt and pepper.

Boil potatoes, drain and cool. Cut into $\frac{1}{4}$ " cubes. Add parsley, celery, onion juice, lettuce, celery seed and pimento. Mix lightly using two forks, so that potatoes will not pack together. Serve with mayonnaise or boiled dressing or a dressing made of equal parts of boiled dressing and mayonnaise is good with potato salad. Serve on lettuce leaves with meat or tomatoes.

8. *German lettuce salad (sometimes called wilted lettuce).*

1 bunch leaf lettuce.

3 slices bacon, diced and fried with a finely minced onion 4-5 minutes.

Add to bacon a little salt and pepper and 1 tbsp. vinegar. Chop the lettuce. Pour hot bacon fat and vinegar mixture over the lettuce; mix thoroughly and serve immediately.

9. *Beet and lettuce salad*—Boil fresh beets. Drain, cool, and cut in $\frac{1}{4}$ " cubes. Marinate with equal parts of salad oil, vinegar, salt and pepper. Mix equal parts of beets and lettuce. Serve on a lettuce leaf with mayonnaise or boiled dressing.

SALAD DRESSINGS

French Dressing (12)

- $\frac{1}{2}$ tsp. salt
- $\frac{1}{4}$ tsp. pepper
- 4 tbsp. vinegar
- 4 tbsp. olive oil

Mix ingredients and stir until well blended, or put into a bottle and shake well before using.

Mayonnaise (12)

- 1 tsp. mustard
- $\frac{1}{2}$ tsp. salt
- cayenne
- 1 c. olive or other salad oil
- 2 tbsp. vinegar or
- 2 tbsp. lemon juice
- 1 egg

Mix the mustard, salt and cayenne; when well blended add the unbeaten egg and beat slightly with a Dower egg beater. Add a quarter of the oil and beat steadily, then add another quarter and continue beating. Repeat until all the oil is added, then beat in the vinegar or lemon juice. If the vinegar is very acid it should be diluted with water.

Boiled Dressing.

- $\frac{1}{2}$ tsp. salt
- $\frac{3}{4}$ tsp. mustard
- 1 tbs. flour
- 1 tbs. sugar
- 1 egg or yolk of 2 eggs
- 1 tbs. butter
- $\frac{1}{2}$ cup hot water
- $\frac{1}{4}$ c. vinegar

Mix dry ingredients in the top of a double boiler. Add the beaten egg and the water and vinegar. Cook over boiling water stirring constantly until thick. Remove from heat, add the butter. Strain if necessary. Chill.

10. *Cream of lettuce soup No. I.*

- 1 good sized bunch of lettuce
- 1 pt. of milk
- 1 tbs. flour
- $\frac{1}{2}$ tbs. grated onion
- $\frac{1}{2}$ tbs. butter
- $\frac{1}{2}$ tsp. salt
- few grains of pepper

Cook chopped lettuce in a very small amount of water until tender, stirring constantly. Drain, saving the water, there should be approximately $\frac{1}{2}$ cup. Press lettuce through a sieve and return it to the water. Add milk and onion. Combine flour and butter in top part of double boiler. Add a little of the milk mixture, make a smooth paste, add rest of milk mixture. Stir constantly until thickened. Add salt and pepper and serve at once.

11. *Cream of lettuce soup No. II.*

- 2 cups white stock (no white sauce is satisfactory)
- 2 bunches of leaf lettuce (finely chopped)
- 6 tbs. cooked rice
- 6 tbs. cream
- $\frac{1}{2}$ tsp. onion finely chopped
- 1 tbs. butter
- 1 tbs. egg yolk
- salt
- small piece of nutmeg
- 3 pepper berries

Cook onion five minutes in butter. add lettuce. rice. seasonings and stock. cook five minutes then remove from the heat. Mix the egg yolk with the cream and add to the other ingredients, stirring until well combined. Cook in double boiler until thickened. Before serving remove pepper berries and nutmeg or soup may be strained.

12. *Stewed lettuce.*

- 2 tbs. butter
- 2 tbs. flour
- $\frac{1}{4}$ c. cream
- 1 tbs. lemon juice

salt and pepper

2 bunches of Ontario leaf lettuce

Cook lettuce in salted boiling water for 20 mins. Drain and put in a pan of cold water for 20 mins. This cold dip tends to prevent the lettuce from becoming mushy. Then drain and chop lightly. Make a cream sauce by combining the butter, flour, lemon juice and cream. Add the lettuce to this mixture. Heat and serve it at once.

13. *Boiled lettuce.*

Cook lettuce for 10-15 mins. in sufficient boiling salted water to just cover it and prevent it from burning. Lettuce requires more water in cooking than spinach. Dip in cold water. Drain, chop lightly, heat in a saucepan with butter, salt and pepper. Serve immediately.

14. *Creamed lettuce.*

Cook lettuce in boiling salted water to just cover, from 10-15 minutes. Dip in cold water. Drain, chop lightly. Heat in a saucepan with butter, salt and pepper. Turn into a dish and cover with either a white sauce or cheese sauce.

(a) *White Sauce.*

2 tbsp. butter

2 tbsp. flour

salt and pepper

1 cup milk

Melt butter in top part of double boiler; blend in the flour and seasonings. Add milk gradually, stir and cook until thick.

(b) *Cheese Sauce.*

2 tbsp. butter

2 tbsp. flour

salt, pepper, paprika or cayenne

1 cup milk

1-3 cup grated cheese

Make white sauce as above. Add cheese. Stir until melted.

15. *Peas with lettuce.*

1 quart shelled peas

2 tbsps. butter

1 bunch leaf lettuce

1 small onion

1 tsp. sugar

salt and pepper

boiling water

Put all ingredients in a saucepan. Add salt and boiling water to cover. Cook for $\frac{1}{2}$ hour. Drain and serve immediately.

16. *Spinach and lettuce.*

$\frac{1}{4}$ lb. spinach

1 bunch leaf lettuce

Cook spinach and lettuce in boiling water to just cover until tender. Drain, chop, and serve immediately. This may be served with poached eggs.

17. *Lettuce loaf.*

2 lbs. lettuce

2 eggs

1 tsp. salt

1 cup fine bread crumbs

1 cup buttered bread crumbs

$\frac{1}{4}$ cup grated cheese

Cook lettuce in boiling salted water to just cover. Drain, dip in cold water; chop finely. Add beaten eggs, salt, and bread crumbs. Place in well greased baking dish. Cover with one cup buttered crumbs, mixed with $\frac{1}{4}$ cup grated cheese. Bake until brown on top. Serve with cheese or tomato sauce.

18. *Braised Lettuce.*

- 1 bunch leaf lettuce
- 2 carrots
- 2 small onions
- 6 slices bacon
- 1-2 cloves
- salt and pepper

Chop lettuce. Place some finely chopped bacon on bottom of casserole. Add chopped carrots, onions and lettuce. Season with salt and pepper. Cover with remainder of finely chopped bacon. Cook in moderate oven 40 minutes-one hour.

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(Revised April, 1934)

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The Weeds of Ontario

By J. EATON HOWITT, M.S.A.

INTRODUCTION

The remedial measures recommended in this bulletin for the suppression of Perennial Sow Thistle, Twitch Grass, Wild Mustard or Charlock and Bladder Campion are those which have proven satisfactory in the co-operative experiments in weed eradication conducted by the Ontario Agricultural College for a period of seventeen years. The result of these experiments were unique in that they furnished for the first time, experimental proof regarding the effectiveness of methods recommended for weed control. All the other methods of cultivation and cropping outlined in this bulletin have been tested by practical farmers under ordinary farm conditions. The recommendations made regarding the use of chemical weed killers are based on the results obtained from three years of extensive experiments conducted by the Department of Botany with commercial weed killers and other chemicals.

WHAT IS A WEED?

There are several definitions of a weed, viz.: "A plant out of place"; "Any injurious, troublesome or unsightly plant that is at the same time useless, or comparatively so"; "A plant which interferes with the growth of the crop to which the field is temporarily devoted."

INJURIOUS EFFECTS OF WEEDS

1. They absorb soil moisture and thus lessen the supply of water available to the crop plants. "An average Mustard plant pumps from the soil about fourteen ounces, or seven-tenths of a pint, per day."
2. They use up the plant food in the soil, and thus rob the crop plants. Furthermore, they often mature their seeds before the crop plants, and during the time they are ripening their seeds draw heavily upon the plant food in the soil, and thus leave little available for the crop plants when they require it to mature their seeds.
3. They shade, crowd and choke out useful plants. Weeds frequently grow more vigorously than the crop plants, and thus often stand above them, preventing the light and air required for healthy growth from reaching them.
4. Weeds are a constant source of expense. They increase the cost of every operation, in the preparation of the land, and in the seeding, cultivating, harvesting and marketing of the crop.
5. They may interfere with the regular rotation of crops. It is sometimes necessary, on account of some particular weed, to drop some crop from the rotation entirely.

6. Some weeds, such as Water Hemlock and Horsetail, are poisonous to stock. Quite frequently reports are received of stock being poisoned by eating such weeds.

7. Milk is often tainted by the cows eating such weeds as Wild Garlic and Stink-weed.

8. The market value of seed grain, clover and grass seeds is much decreased by the presence of weed seeds in any quantity.

9. Weeds often harbour or favour the development of injurious insects and fungous diseases.

10. Weeds are unsightly, and their presence detracts very materially from the value of a farm. No man cares to buy a weedy place if he can secure a clean one.

INTRODUCTION AND SPREAD OF WEEDS

Most of the injurious weeds found in this Province have come directly or indirectly from other countries. They are brought in and conveyed from field to field and farm to farm in various ways:

1. *By the wind.* Seeds which are carried by the wind usually have tufts of fine, silky hair attached to them. Such are the seeds of the Dandelion, Canada Thistle, Sow Thistle (annual and perennial), Willow Herb, and Cotton Grass. These and similar seeds are wafted to and fro, till they become attached to the soil and commence to grow. In some cases, as in the Dock and Wild Parsnip, the seeds are winged; in others the pod containing the seed has flat and extended edges, exposing much surface to the wind. The Pennycress is an example of the latter.

Some weeds are rolled along the ground by the wind. To this class belong the Russian Thistle and the Tumbling Weed of the Prairie Provinces. When these weeds ripen, they break off close to the ground; and, being light, they are easily carried by the wind, especially on an open prairie, and the seeds drop out as the weed rolls from place to place.

An examination of snow drifts in Dakota, some years ago, showed the presence of many weed seeds. Thirty-two seeds of nine species were found in two square feet of a drift. In the same place it was observed that a twenty-five mile wind carried wheat seed a distance of thirty rods in a minute.

Seeds which become sticky when wet often adhere to leaves, and go wherever the leaves are carried by the wind. This is true of the Plantain.

2. *By water.* Some seeds, especially those of aquatic plants, are distributed by water. Darwin maintained that many seeds, dropping into the sea, or being washed in from the shore, might be carried nearly a thousand miles by the movements of the water without injuring their vitality. Seeds which float on the surface of the water are carried to and fro by the wind till they find lodgment and begin to grow; and many, of various kinds, are carried from high to low ground and distributed far and near by the rills and streams which flow from mountain, hill and upland after heavy rains and spring thaws. The common Speedwell and Ragweed are often distributed in this way.

3. *By birds and other animals.* Seeds are distributed by animals in a variety of ways. "It is estimated that about 10 per cent. of all flowering plants possess seeds which are dispersed by means of barbed or cleaved processes." By these barbs or processes the seeds cling to the feathers of birds and the hairy coats of animals, and in this way are carried from place to place. To this class belong the Bur, Burdock, Hound's Tongue, Bedstraw, and such like. And the seeds of some plants, such as

Mistletoe and Meadow Saffron, exude sticky substances which cause them to adhere to birds and other animals.

In the hardened earth taken from the feet of birds, Darwin found a large number of seeds, many of which germinated; and it is undoubtedly true that seeds are often conveyed from one place to another in the dirt that clings to the feet of animals.

Seeds often pass through the stomachs of animals without being digested; and, during their passage, they are conveyed hither and thither by the animal, and finally deposited, to grow and reproduce their kind, whether of weeds or useful plants. Every farmer knows the truth of this statement as regards cattle, horses and swine; and it may be mentioned that Darwin picked from the excrement of small birds twelve kinds of seeds, which were perfect in form and germinated in nearly every instance.

Ants, locusts, and other insects also do something in the way of distributing the seeds of certain plants, including noxious weeds.

4. *By man.* Man himself, however, has most to do with the spread of troublesome weeds, chiefly through the agency of impure seed, railroads, implements, farm yard manure and feed-stuffs. Too much stress cannot be placed on the importance of pure seed. The sowing of impure seed can be held chiefly responsible for the spread of many bad weeds through the Province. Either through carelessness or ignorance far too much impure seed is sown every year. Such seed is dear at any price. Pure seed is the farmer's right by law and he should insist upon having it.

Many weeds are carried from one province or country to another in the fodder and litter used by animals in transit on railways and in grain carried by rail. More or less of the grain, litter and fodder are scattered at places along the track, and at stations where grain and animals are unloaded and cars cleaned out. Weeds thus get a start and spread to neighbouring farms. The Russian Thistle was introduced in this way.

When implements are transferred from one field to another pieces of dry earth or sod are frequently dislodged, and new weed seeds are introduced. This is a common method of spreading weed seeds all over farms and throughout whole neighbourhoods. Threshing machines from dirty farms are well-known sources of trouble under this head.

Fresh barnyard manure is very often full of weed seeds, and should be rotted, or piled and allowed to heat thoroughly before it is applied to clean land.

CLASSIFICATION OF WEEDS

Weeds may be classified according to the length of time they live, as follows:

Annuals, or weeds which germinate, bloom, fruit and die in one year or season. Wild Mustard is an example.

Winter Annuals, which germinate late in summer or autumn, pass the winter as seedlings or immature plants, and complete the cycle of their existence by blooming, fruiting and dying during the following summer. Such are Chess and Shepherd's Purse.

Biennials, which produce leaves and roots the first year, and flowers and seeds the second year, after which they die. The Wild Carrot and Evening Primrose are familiar examples.

Perennials, which last from year to year, blooming and seeding every year. These are divided into two classes:

(1) Those with underground creeping stems, such as the Canada Thistle.

(2) Those with roots which do not spread underground, such as Chicory, Plantain and Dock.

It is important to know the class to which a weed belongs, as the method of eradicating an annual is often very different from that required to destroy a perennial.

COLLECTION AND IDENTIFICATION

Not only every seedsman, but every farmer and every teacher in a rural school, should have a collection of weed seeds for reference and comparison, in order that he may be able to detect and identify such seeds when they are in grass seed, clover seed, rape seed, or any other kind of seed which is sold or offered for sale. A good collection can be made easily in the summer months. All that is necessary is a number of small

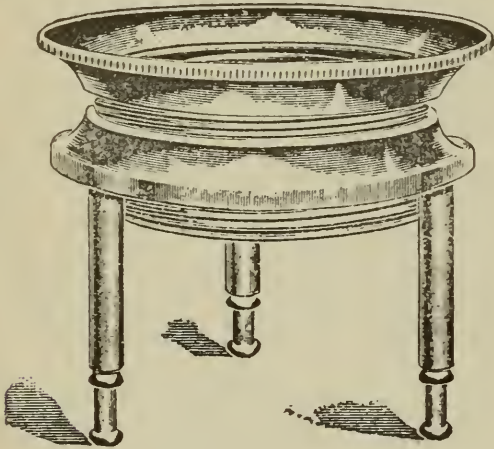


Fig. A. Tripod Magnifier

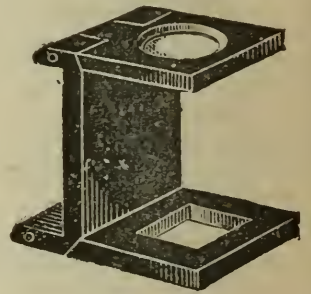


Fig. B. Linen Tester.

bottles and a little attention at the right time. The so-called homeopathic vials of one drachm capacity are suitable for the purpose, but they should be carefully and plainly labelled. If they are not so labelled, the collection will be valueless.

A small magnifying glass is very useful in identifying seeds. Perhaps the most convenient glass for the purpose is the tripod magnifier (Fig. A), costing about one dollar. The linen-tester (Fig. B) is cheaper, but yet quite serviceable.

GENERAL PRINCIPLES IN THE CONTROL OF WEEDS

1. Never allow weeds to mature seeds. Cut those on the roadsides, headlands, in waste places and in the fence corners, as well as those in the fields.

2. Be constantly on the watch for the appearance of new weeds. Do not wait until a weed has become established before finding out what it is. It is a comparatively easy task to get rid of a few plants of Perennial Sow Thistle, but a long, tedious and costly operation to clean a field which has become overrun by it.

3. Sow only pure seed. Impure seed is dear at any price. Pure seed is the purchaser's right by law and he should insist upon having it. Everyone who has to purchase agricultural seeds should have sufficient knowledge of the Dominion Seeds

Act to be able to realize the value of the various grades of seed defined by the Act and under which grade names agricultural seeds are sold in Canada. No seed grain, clover or grass seed should be sown without ascertaining its weed seed contents. Any farmer can have his seeds examined and reported upon as to purity by submitting samples to a Dominion Seed Laboratory (see page 9).

4. In dealing with perennial weeds with creeping underground "roots," be careful not to harrow or cultivate through patches and drag the "roots" all over the field.

5. See that the separator is cleaned before being brought upon the farm and that it is fitted with screens to prevent weed seeds going out in the straw or getting into the grain. Burn or bury the refuse from the separator and do not throw it around the barnyard or on the manure heap or use it for chicken or hog feed.

6. Avoid feeding stock upon chop containing weed seeds in any quantity. Such food should be boiled before being fed.

ERADICATION OF WEEDS

The most important points under this head are:

First, a determination to get rid of weeds and to keep the land clean.

Second, the method or methods of tillage and cropping.

For various reasons, very few farms in the older sections of the Province of Ontario are free from weeds, and the question how to clean our lands without incurring too much expense is one of the most important which can engage the attention of Ontario farmers.

In the first place, all obstructions to cultivation, such as piles of stone, must be removed—hauled away to the woods or an out-of-the-way corner in the winter or some other slack time. Secondly, places for harbouring weeds, such, for example, as snake fences, should be got rid of as soon as possible.

Annuals and Biennials. Wild oats, wild mustard seed, and some other seeds belonging to these classes, have great vitality. If down pretty well beyond the reach of the air, they will live for years, and will germinate as soon as they are brought near the surface.

The best way to destroy annuals and biennials is by thorough and frequent shallow cultivation early after harvest in stubble ground and in sod plowed for the following year, and at the proper season (spring and summer) among what are called "hoed crops," that is, potatoes, carrots, turnips, mangels, Indian corn, etc. By shallow cultivation the seeds are kept near the surface and by frequent stirring of the soil they are made to sprout; and, having sprouted, they can be killed by further cultivation. Those which sprout late in the fall are destroyed by the winter frost. It is impossible to get rid of such weeds by plowing the ordinary depth, say seven or eight inches, once in the fall or at any other time. Plow shallow (not more than four inches in sod and three inches in stubble ground), and harrow and cultivate frequently, as by each stirring of the soil fresh seed is made to sprout, and what has already sprouted is destroyed. When necessary to loosen the soil to a greater depth, use a grubber or subsoil plow.

Perennials. It is necessary to study the habits of perennial weeds to see how they grow and propagate themselves from year to year, in order to keep them in check; and a close examination of almost any of them will show that the buds from which the young plants start are near the surface of the soil. Hence shallow cultivation, similar to that mentioned above, is the effective method of destroying them. Disc harrows cut the shallow, creeping "roots" into fragments, which bud and greatly increase the difficulty of eradication. Deep plowing only transplants the

buds to a greater depth, and increases the trouble. Plow shallow (see preceding paragraph), and harrow and cultivate frequently, using a grubber or subsoil plow when it is necessary to stir the soil to a greater depth. As above, the cultivation must be early after harvest and throughout the fall in stubble ground and sod, and in spring and summer among corn, potatoes and root crops. Ill-timed, irregular or partial cultivation only makes all weeds grow more vigorously. Plan so that fields over-run with perennial weeds such as Twitch Grass and Perennial Sow Thistle receive the maximum amount of cultivation during the driest and hottest part of the summer.

GENERAL METHODS FOR THE ERADICATION OF WEEDS

I. CROP ROTATION

Crop rotation is of utmost importance in dealing with weeds. Some sharp, short rotation of crops should be adopted, which will allow of the frequent use of the cultivator, the cutting of the weeds before seeding and the introduction of smother or hoed crops. One cannot recommend a system of cropping that will be suitable to all kinds of farming. Each farmer must select the rotation most suited to his conditions, keeping in mind those features of rotation which will enable him to fight the particular weed with which he has to contend.

The following rotation is recommended for Eastern Canada, by Doctor E. S. Hopkins, Dominion Field Husbandman.

First year—grain.

Second year—corn or other inter-tilled crops.

Third year—grain.

Fourth year—clover hay.

Fifth year—timothy or pasture.

This rotation has the advantage of providing considerable opportunity for cultivating the land, which is necessary to kill weeds. If couch grass or other perennial weeds are present the timothy sod should be ploughed about August first, immediately after the hay has been removed. Thorough cultivation should then be given during the remainder of the fall and the land reploughed again in the late fall. In the following spring the land should be well cultivated before the grain is seeded and after the grain crop has been removed, the land should be ploughed and thoroughly worked during the fall.

In the second year of the rotation, the inter-tilled crop should be thoroughly worked. This rotation provides ample opportunity to thoroughly work the land and thereby control weeds satisfactorily. However, unless the land is thoroughly worked, the rotation itself will not be a success.

2. HOED CROPS

The growing of such crops as potatoes, corn and roots provides a means by which many weeds may be effectively fought. Hoed crops alone do not give entire satisfaction in fighting creeping perennial weeds. This is due to the fact that in cultivating and hoeing the rootstocks are cut but not all destroyed, and in a short time begin to grow again. Hoed crops, therefore, should not be depended upon alone to eradicate creeping perennials but should be used in connection with other methods as outlined further on.

3. SUMMER FALLOWING

This method is extremely efficacious in some seasons with all sorts of weeds including the Perennial Sow Thistle. By fallowing for weeds a bare fallow is understood, that is, one which is given sufficient cultivation to prevent weeds from making any growth above the ground. A neglected fallow is nothing more or less

than a weed patch and is useless and a source of contamination for every field on the farm. Summer fallowing for the whole season is objectionable because it is costly, a season's crop is lost, considerable labour is required, and valuable plant food materials are leached from the soil. It is usually better therefore, to fallow only for a portion of the season, either before putting in a hoed crop or smother crop, or immediately after breaking up meadows or pastures.

4. EARLY AFTER-HARVEST CULTIVATION

This is one of the best ways to destroy annual and winter annual weeds, such as False Flax, Corn Cockle and Wormseed Mustard. Plow shallow immediately after harvest and harrow and cultivate frequently. By the shallow plowing the weed seeds are kept near the surface, and by the frequent stirring of the soil they are made to sprout, and, having sprouted, they are easily destroyed by further cultivation.

5. SEEDING DOWN

Many weeds can be suppressed or held in check by seeding to grass for hay or pasture. Alfalfa and sweet clover are excellent for this purpose. This method has the advantage of requiring little labour, which is expensive at the present time. Cutting the hay crop early will prevent most weeds from maturing any quantity of seed. Close pasturing, especially with sheep will in time destroy most weeds, even perennials.

6. WEEDS IN PERMANENT PASTURES

In Ontario there is a large acreage of pasture land which cannot be cultivated and brought under crop rotation. Much of this land is weedy and produces comparatively little pasture. Recent work on pasture improvement done in this Province and other parts of the Dominion indicates very clearly that such pasture land may be freed from many weeds and made to yield more abundantly by the judicious use of commercial fertilizers in combination with good management, including in some cases re-seeding with a suitable pasture mixture.

7. SHEEP DESTROY WEEDS

A flock of sheep will do much to keep a farm free from weeds, and it is to be deplored that sheep are not more generally kept upon Ontario farms. **"When an abundance of succulent pasture of the finer grasses is provided, weeds can scarcely be said to be favoured by sheep as a staple part of their diet. Sheep will, however, even when good pasture is provided them, vary their diet by nipping off seedling plants or the fresh growing parts, and the bloom with its contents of sweets from older plants of many of our common weeds. When their pasture is depleted, sheep feed readily on Wild Mustard, Ox-eye Daisy, Yarrow, Plantain, Perennial and Annual Sow Thistle, Wild Vetch or Tare, Dock, Sorrel, Lamb's Quarters, Milkweed, Ragwort, Burdock and Shepherd's Purse. In fact, there are few weeds that sheep will not eat, to the extent of preventing them from seeding, if there is not enough of their favourite grasses to satisfy them. It is only when the supply of food is unusually short that sheep will feed on plants having leaves and stems covered with bristly hairs or spines, or with a flavour that is obnoxious to them. When the plants are young and tender, however, sheep have been observed to eat such weeds as Ragweed, Blueweed, Cockle, Orange Hawkweed, Hound's Tongue, Stickseed, Mullein, Canada Thistle, Stinkweed, Toadflax, and others that are bristly or have a pungent flavour. Thorough cultivation with a systematic rotation of crops, combined with the maintenance of as many sheep as can be kept to advantage, is a certain and profitable means of keeping weeds under control."*

*Farm Weeds of Canada.

8. SMOTHERING

The aim of this method is to kill weeds by depriving them of light and air. This is accomplished by getting some quick-growing crop such as rape or buckwheat, established on the land while the weeds are in a weakened condition. The result is that the smother crop soon occupies every available foot of the land and forms a dense shade in which the weeds in their weakened state cannot continue to grow. Smother crops give the best results when they follow intensive cultivation.

9. HAND PULLING

Hand pulling and a total removal of weeds is the most effective means of destruction, but of course is only practical with shallow-rooted weeds, not very abundant in a field. Weeds in a clover seed crop should be hand pulled. By this method it is easier to prevent weed seeds from getting into clover seed than it is to remove them after they get in. Small patches of perennial weeds can be destroyed by digging out the plants with a fork, "roots" and all, and burning them. Great care must be taken to get every bit of the "roots." Then the spots which have been dug over should be watched and if new shoots appear they should be taken out at once. In an ordinary season several diggings will be required in order to completely exterminate a creeping perennial.

10. PURE SEED

The importance of sowing pure seed only cannot be too strongly emphasized. Impure seed does much to aggravate the weed problem of Ontario. Clover and grass seed especially should receive the closest care and scrutiny. In the past, either through ignorance or carelessness, far too much impure clover and grass seed has been sown in this Province. Out of some 235 samples of clover and grass seed examined for purity by this Department, seventy-six were disqualified on account of containing weed seed impurities in excess of those allowed by the Dominion Seeds Act. Every one interested in clean farming should learn to know the common weed seed impurities of commercial seeds, and have sufficient knowledge of the Dominion Seeds Act to enable him to purchase his seed with an intelligent appreciation of the values of the various grades.

IMPORTANT POINTS IN THE DOMINION SEEDS ACT

W. H. WRIGHT, M.A., DOMINION DEPARTMENT OF AGRICULTURE

- (1) Grades are provided for all classes of agricultural and garden vegetable seeds.
- (2) Seed which is sold for the purpose of seeding must be graded except in the case of garden vegetable seeds when grading is optional, but nevertheless vegetable seeds must conform to the minimum standard of purity and germination required by regulations.
- (3) The Act does not apply to:—
 - (a) seed that is sold to be cleaned or graded before being offered for sale for the purpose of seeding;
 - (b) seed that is held in storage for the purpose of cleaning or grading, provided that the place of storage is not accessible to purchasers of seed or the seed is labelled "held for recleaning";
 - (c) the seeds of cereal grains, buckwheat, field peas, field beans and corn that are grown, sold and delivered by any farmer, on his own premises, for seeding by the purchaser himself, unless the purchaser of the said seed obtains from the seller at the time of the sale thereof a certificate that the said seed is supplied to him subject to the provisions of this Act;

(d) the sale of Elite stock seed that may be produced and sold by any plant breeder to a seed grower, unless such seed be again sold.

(4) Alfalfa, clovers and grasses sold for seeding, either singly or in mixtures, are not exempt under any conditions and must be graded even when sold by one farmer to another on his own premises.

(5) There are nine grades which may be put into two groups:—

(a) *Registered Seed*, that is to say, seed derived from an inspected seed crop that was pure as to variety and was registered by the Canadian Seed Growers' Association. These grades are Registered No. 1, Registered No. 2 and Registered No. 3.

(b) *Seed of Commerce*—seeds which are not eligible for registration come in this group. The grades are No. 1, No. 2, No. 3, No. 1 Mixture, No. 2 Mixture and No. 3 Mixture. These grades are based on the following characters:—

(i) Freedom from weed seeds.

(ii) Viability or ability to produce plants under the most favourable conditions.

(iii) Freedom from the seeds of other cultivated plants.

(iv) Freedom from disease.

(v) General quality: plumpness, soundness, colour, uniformity, freedom from chaff and dirt.

(vi) Purity of variety when this can be determined from seed characters.

(6) Use of false or spurious variety names or misleading statements as to quality, grade, character or description of either seeds or plants is illegal.

(7) A licence must be obtained before a new variety name may be used. Names are considered to be "new" if they were not in general use in the year beginning March, 1922, and ending March, 1923.

(8) Sweet clover is considered to be a cultivated seed only when graded and sold as sweet clover; otherwise it is classed as a weed seed.

(9) Seeds cannot be imported into Canada for seeding purposes unless they conform to the minimum requirements of the Act.

(10) Seed testing laboratories are established to give service to farmers, seedsmen and other interested persons at two points in Ontario. Persons living in Ontario west of Toronto and in the Counties of Ontario, York, Simcoe, Muskoka, and Parry Sound should send samples for testing to the Seed Commissioner, P.O. Box 810, Station "F", Toronto. Those living elsewhere in Ontario should communicate with the Seed Commissioner, Seed Branch, Confederation Building, Ottawa. Copies of the Seeds Act can be obtained at the above addresses.

DIRECTIONS FOR TAKING SAMPLES FOR GRADING

BY W. H. WRIGHT

The grades issued by the Seed Branch are based on the general quality and tests for purity and germination which are made of the samples sent into the laboratories. Since these samples are necessarily small it is most important that they should represent as accurately as possible the bulk of the seed from which they are taken. Very few farmers possess "the small Trier" and the larger "sticker" which are the regulation implements for taking samples. A farmer may have occasion to take samples of seed (a) during the process of cleaning; (b) from a bin; (c) from bags.

(a) *Taking samples while cleaning.* This is the best time to take samples. Frequent samples should be taken of the seed as it comes from the fanning mill and put together in a pile. This seed should then be carefully mixed and poured out on a clean sheet of paper or canvas. The pile of seeds should be mixed again, then divided into four. One quarter should be separated, mixed and quartered. This process

should be carried on until a sample of the correct size for sending to a laboratory for testing is obtained.

(b) *Taking samples from bins* when there is not a sticker to hand is difficult. The best method is to take five samples from different places from the top and the same number by thrusting the hand as far as possible into the bin at different points. These samples should be mixed and quartered as already described.

(c) *Taking samples from bags.* When there is only one bag or a part of a bag it is often possible to empty the bag in a clean place, mix and take samples from three or four places in the pile. These samples should then be mixed together and quartered as already described. When there are several bags it is generally considered satisfactory to take two samples from each bag, one from the top and one by thrusting the hand well into the bag. These samples are then mixed together, quartered and re-quartered until a sample of desired size is obtained.

Size of sample required. Cereal grains and buckwheat—one pound. Flax, rape, mangels, clover, timothy, millet, vetches, sorghum, and larger grasses, two ounces. Small grasses as red top, blue grass, etc., one ounce.

KINDS OF WEED SEEDS TO BE LOOKED FOR IN GRASS AND CLOVER SEEDS

The following are the more frequent impurities found in the various kinds of grass and clover seeds:

In Alfalfa. Ribgrass or buckhorn, ragweed, chicory, dock, dodder, wild carrot, bladder campion, green foxtail, lamb's quarters, sweet clover, pale plantain, Russian thistle, yellow foxtail, barnyard grass, black medick, smartweed.

In Red Clover. Ribgrass or buckhorn, bladder campion, white cockle, night flowering catchfly, dock, ragweed, Canada thistle, wild carrot, false flax, green foxtail, lamb's quarters, pale plantain, black medick, sheep sorrel, sweet clover, common plantain, mayweed, knotweed, pigweed and field pepper grass.

DESCRIPTIONS OF THE WEED SEEDS ILLUSTRATED

1. GREEN FOXTAIL. Colour, brown, often mottled with lighter spots, greenish yellow with the hull on; shape, oval, blunt at both ends, one face, flattened and the other rounded; size $\frac{1}{12}$ of an inch long; the surface granular striate. Yellow Foxtail seed is brown, larger, about $\frac{1}{8}$ to $\frac{1}{10}$ of an inch long and surface conspicuously wrinkled crosswise.

2. CHESS. Straw-coloured, somewhat boat-shaped; back rounded, seven-nerved; size about $\frac{1}{3}$ of an inch long, surface deeply creased on one face with a row of spines near each margin.

3. WILD OATS. Brownish-black to straw colour, oat-shaped with a conspicuous sucker-mouth scar at the base; $\frac{3}{4}$ of an inch long; surface hairy especially towards the base and with a strong, bent and twisted awn on the back.

4. COUCH GRASS. Straw-coloured to dirty grey, size $\frac{1}{2}$ to $\frac{3}{8}$ of an inch long; narrowly boat-shaped with hull on, very narrowly wheat-shaped with hull off; surface indistinctly nerved on the rounded face, sometimes with a short awn.

5. CURLED DOCK. Colour, reddish brown; beechnut or buckwheat shaped; $\frac{1}{12}$ to $\frac{1}{8}$ inch long, smooth and shiny on the surface.

6. SHEEP SORREL. Brown to ash brown in colour; buckwheat or beechnut shaped; about $\frac{1}{20}$ of an inch long; surface of the hull very finely ridged, surface of the seed itself smooth and shiny.

7. LAMB'S QUARTERS. Colour, shiny black with hull off, usually covered with finely granular greyish hull; lens-shaped with a projection at one side; size about $\frac{1}{16}$ of an inch in diameter; surface of seed smooth; hull finely granular.

8. PURSLANE. Colour, dull black, irregularly egg-shaped with a notch at the small end; size, about $\frac{1}{16}$ of an inch in length; surface covered with rows of indistinct blunt tubercles.

9. CORN COCKLE. Black or dark reddish brown in colour; very irregular in shape, usually somewhat kidney-shaped or angular, about $\frac{1}{12}$ to $\frac{1}{8}$ of an inch in length; surface covered with regular rows of distinct spines or teeth.

10. BLADDER CAMPION. Colour, light brown to brownish grey; kidney-shaped varying to somewhat angular or heart-shaped, usually with conspicuous depressions near the scar; $\frac{1}{14}$ to $\frac{1}{16}$ of an inch in length; covered with pointed tubercles arranged in regular rows.

11. WHITE COCKLE. Light ash colour; kidney-shaped; about $\frac{1}{16}$ of an inch in length; surface covered with blunt tubercles arranged in regular concentric rows.

12. NIGHT FLOWERING CATCHFLY. Colour, greyish brown; kidney shaped; about $\frac{1}{14}$ to $\frac{1}{16}$ of an inch in length; surface covered with blunt tubercles, which are very close together and not in regular and definite rows.

13. PEPPER GRASS. Colour reddish yellow to reddish brown; about $\frac{1}{12}$ of an inch in length; egg-shaped in outline but flattened with a slight wing around the margin; the surface with a conspicuous curved groove about two-thirds the length of the seed.



The small drawings beside the enlarged drawings represent the natural size of the seeds.

14. PENNY CRESS. Colour, purplish or bronzy brown; egg-shaped but flattened with a minute notch at the small end; about $\frac{1}{12}$ of an inch in length; surface covered with conspicuous wavy eccentric ridges which start and end near the small end of the seed.

15. WILD MUSTARD. Reddish brown to slate black in colour; spherical; $\frac{1}{16}$ of an inch; surface smooth with an inconspicuous scar.

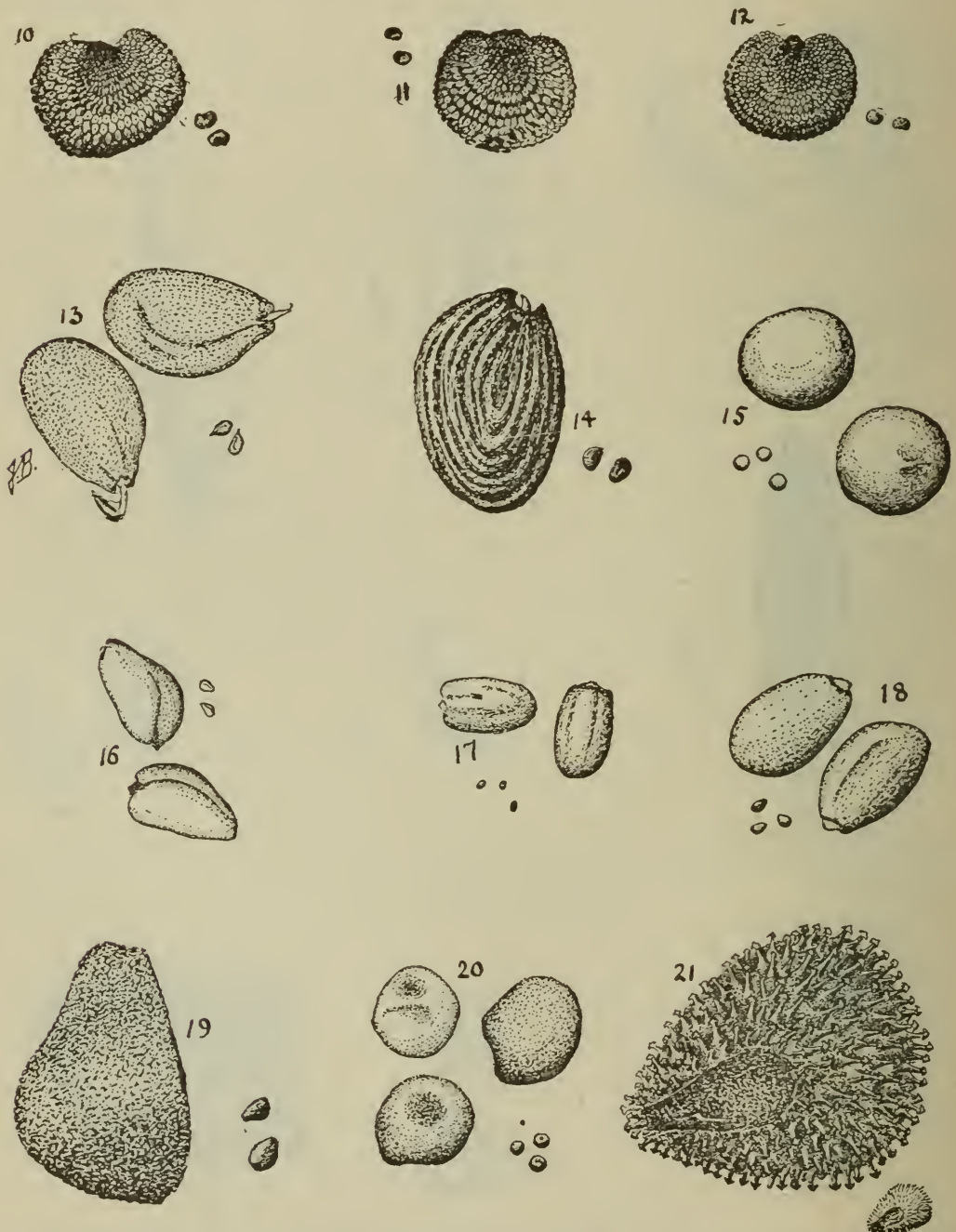
16. WORMSEED MUSTARD. Colour, reddish yellow with a dark spot at the large end; irregularly carrot-shaped; about $\frac{1}{24}$ of an inch in length; surface with a distinct longitudinal groove.

17. SHEPHERD'S PURSE. Colour, yellowish red, somewhat U-shaped; about $\frac{1}{25}$ of an inch in length, usually with two distinct grooves on each surface.

18. SMALL SEEDED FALSE FLAX. Colour, reddish brown with a minute whitish spot at the small end, somewhat oval in shape, about $\frac{1}{20}$ of an inch in length, the surface very finely granular roughened and grooved lengthwise.

19. FIELD BINDWEED. Colour, grey brown or seal brown; irregularly pear-shaped; about $\frac{1}{8}$ to $\frac{1}{6}$ of an inch in length; surface coarsely roughened.

20. DODDER. Colour, yellowish to grey brown, somewhat egg-shaped ranging in size from $\frac{1}{16}$ to $\frac{1}{24}$ of an inch in length; surface minutely roughened.



The small drawings beside the enlarged drawings represent the natural size of the seeds.

21. HOUND'S TONGUE. Greyish brown in colour, somewhat pear-shaped in outline; about $\frac{1}{8}$ of an inch long and the surface covered with hooked prickles.

22. BLUE WEED. Colour, greyish or blackish brown, somewhat irregularly mitre-shaped with a triangular scar at the base; about $\frac{1}{8}$ of an inch in length; surface irregularly roughened and pitted.

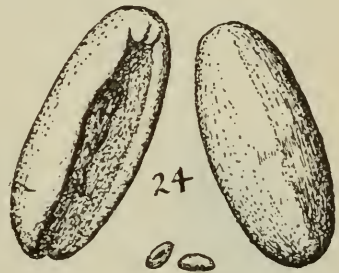
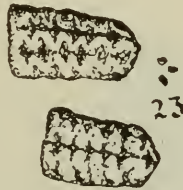
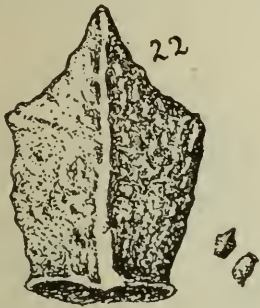
23. MULLEIN. Light brown in colour, somewhat thimble-shaped, about $\frac{1}{25}$ of an inch in length; surface pitted, with zig-zag ridges between the pits.

24. RIBGRASS. Colour, amber brown to dark brown; datestone-shaped or boat-shaped; about $\frac{1}{12}$ of an inch in length; surface smooth, except for a scar in the hollowed-out face.

25. COMMON RAGWEED. Greenish straw coloured to brown; somewhat top-shaped with a number of blunt spines around the apex; $\frac{1}{12}$ to $\frac{1}{8}$ of an inch in length; surface with faint longitudinal lines ending in the spines. The seed proper is a little pear-shaped green body but is usually enclosed in the hull described above.

26. YARROW. Colour, bluish grey or brown with white edges, oblong, wedge-shaped, flat, $\frac{1}{16}$ to $\frac{1}{12}$ of an inch in length; surface with very indistinct irregular longitudinal lines.

27. OX-EYE DAISY. Colour, grey and white or black and white, somewhat club-shaped with a small knob at the large end; about $\frac{1}{12}$ of an inch in length; surface with twelve slender conspicuous white longitudinal ribs.



The small drawings beside the enlarged drawings represent the natural size of the seeds.

28. **BURDOCK.** Colour, light brown, mottled with darker brown spots; shape prismatic, curved, tapering towards the base; $\frac{1}{6}$ to $\frac{1}{4}$ of an inch in length; surface slightly roughened with a number of indistinct longitudinal ridges.

29. **CANADA THISTLE.** Colour, light brown; shape, narrowly oblong, pointed at the base and often curved with a rim and nipple at the apex; about $\frac{1}{8}$ of an inch in length; surface smooth, sometimes with a central longitudinal ridge.

30. **CHICORY.** Straw coloured to dark brown, often light brown mottled with dark brown; shape prismatic to cylindric or somewhat wedge-shaped with a crown of scales around the top; about $\frac{1}{12}$ to $\frac{1}{8}$ of an inch in length; surface with fine irregular longitudinal lines.

31. **PRICKLY LETTUCE.** Colour, greenish brown to brown mottled with dark brown; lance-shaped with a slender prominent beak; size about $\frac{1}{6}$ of an inch long; surface with five to seven longitudinal lines.

32. **SPINY ANNUAL SOW THISTLE.** Colour, reddish brown, flat, narrowly oval in outline; about $\frac{1}{8}$ of an inch in length; surface with three to five smooth ridges on each face.

33. **PERENNIAL SOW THISTLE.** Colour, dark reddish brown, somewhat spindle-shaped or oblong; about $\frac{1}{8}$ of an inch in length; surface deeply and closely ridged lengthwise, the ridges cross-wrinkled.

34. **FLEABANE.** Colour, yellowish or greenish brown, narrowly oval in outline with



The small drawings beside the enlarged drawings represent the natural size of the seeds.

a few scattered hairs at the top; $\frac{1}{14}$ to $\frac{1}{18}$ of an inch in length; surface covered with fine indistinct longitudinal lines.

35. DANDELION. Straw colour to red brown; somewhat lance-shaped in outline; $\frac{1}{10}$ to $\frac{1}{8}$ of an inch in length; surface with distinct ridges running lengthwise ending in barb-like teeth pointing towards the apex, which terminates in a prominent beak.

36. WILD CARROT. Colour, yellowish or light brown; oval in outline; about $\frac{1}{8}$ of an inch in length, rounded surface ridged and bearing four rows of spines.

37. PIGEON WEED. Colour, greyish brown, somewhat irregularly pear-shaped with an elliptical scar at the base; about $\frac{1}{8}$ of an inch in length; surface irregularly pitted and ridged.

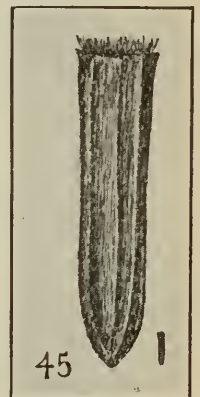
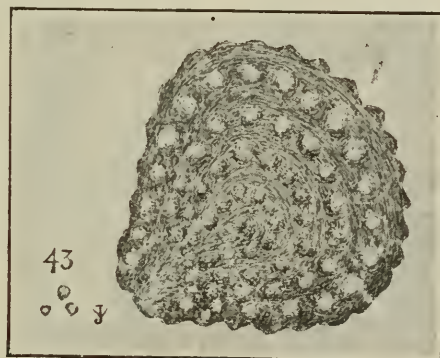
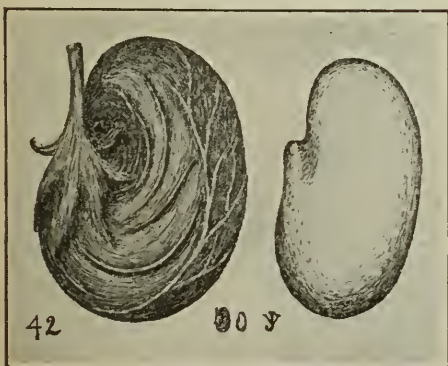
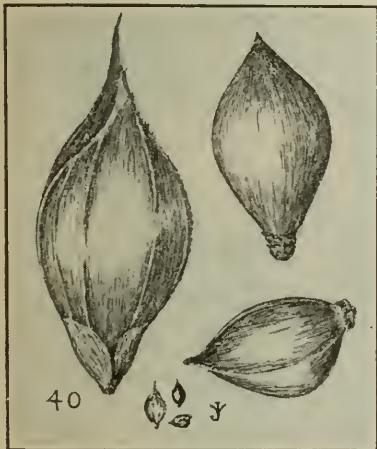
38. BROAD-LEAVED PLANTAIN. Colour, greenish brown to brown; shape very irregular but somewhat angular oval in outline; about $\frac{1}{20}$ of an inch in length; surface covered with a fine indistinct network and with a distinct scar on one face.

39. FIGWEED. Colour, dark reddish brown to jet black; egg-shaped with a minute notch at the small end; about $\frac{1}{24}$ of an inch in length; surface smooth and polished.

40. BARNYARD GRASS. Colour, usually greenish or greyish yellow, somewhat mandoline-shaped, about $\frac{1}{10}$ of an inch long; surface smooth and glossy.

41. OLD WITCH GRASS. Greenish yellow in colour, oval in outline, one face somewhat flattened; about $\frac{1}{16}$ of an inch long with surface smooth and shiny.

42. BLACK MEDICK. Seed found in a black, ribbed pod; yellow in colour; egg-shaped with a minute nose-like projection on one side; about $\frac{1}{12}$ of an inch in length; surface smooth.



43. COMMON CHICKWEED. Colour, reddish grey to dirty grey; shape flat, somewhat kidney-shaped with a small notch at the point; size about $\frac{1}{24}$ of an inch in length; surface covered with fine blunt tubercles in four or five distinct rows.

44. ROUGH CINQUEFOIL. Colour, light yellowish brown, somewhat comma shaped, $\frac{1}{30}$ to $\frac{1}{25}$ of an inch in length; surface covered with curved, branched longitudinal lines.

45. ORANGE HAWKWEED. Reddish brown to jet black in colour, somewhat torpedo or cigar-shaped; about $\frac{1}{12}$ of an inch in length; surface grooved lengthwise.

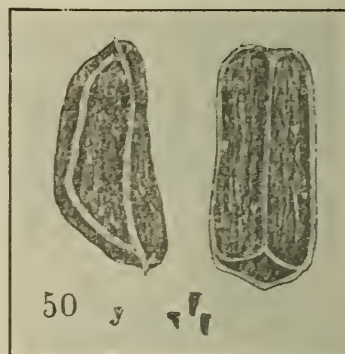
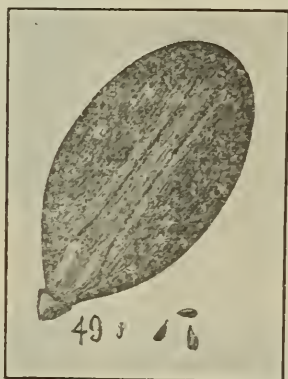
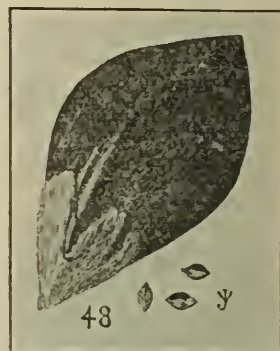
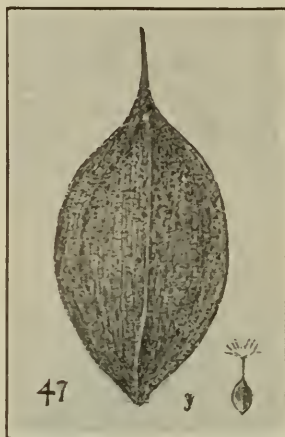
46. CONE FLOWER, YELLOW DAISY OR BLACK EYED SUSAN. Dull black or brownish black in colour; four-sided and peg-shaped; about $\frac{1}{12}$ of an inch in length with very fine longitudinal lines on each face.

47. WILD OR CANADA LETTUCE. Dark brown to black in colour; shape, thin, flat and oval with a slender beak; about $\frac{1}{6}$ of an inch in length; surface with faint cross ridges.

48. WILD BUCKWHEAT, BLACK BINDWEED. Jet black in colour, often covered with a light brown or fawn-coloured husk; buckwheat shaped; about $\frac{1}{8}$ of an inch in length;

49. HEAL ALL OR SELF HEAL. Brownish in colour; oblong, oval, tapering to a small white triangular scar at the base; about $\frac{1}{12}$ of an inch long; surface with dark lines on the margins and centres of the face.

50. EVENING PRIMROSE. Reddish brown in colour; very irregular in shape, some seeds are pyramidal, some prismatic and others wedge-shaped, all with four or five faces; about $\frac{1}{16}$ of an inch in length; each face very minutely ridged.



HORSETAIL FAMILY (*EQUISETACEAE*)

HORSETAIL OR SCOURING RUSH (*Equisetum arvense*, L.)

This plant is found in damp grass lands, in low places in cultivated fields, and on apparently dry sandy land which has a poorly drained subsoil. If fed in quantity in hay it is poisonous to horses.

The Horsetails appear in early spring as small pale stalks with yellowish or brownish heads. Later in the season feathery, tail-like leafy green shoots appear.

These are frequently described by correspondents as being like little pine trees. It is this form of plant which is usually noticed in cultivated fields.

Control. This weed thrives best in sandy or gravelly soil that is not well drained or where the underlying water is not far from the surface of the ground. Good drainage, therefore, is the first essential in control, after which the land should be enriched by applying farmyard manure and given thorough cultivation. Hoed crops in a short crop rotation can be used to advantage in dealing with this weed.

THE GRASS FAMILY (*GRAMINEAE*)GREEN FOXTAIL (*Setaria viridis* (L) Beauv.) (Fig. 1)

A weedy annual grass common in stubble, fallow and root fields; stems tufted, erect, simple or branched from the base, leafy, bearing dense, close spike-like panicles which resemble millet, spikelets small, surrounded by from one to three persistent green bristles. The seed is greenish brown, often mottled with lighter spots. It is greenish yellow with the hull on; shape oval, blunt at both ends, one face flattened, the other rounded; the surface finely and indistinctly granular striate. The seeds are frequently found as an impurity in clover and grass seeds.

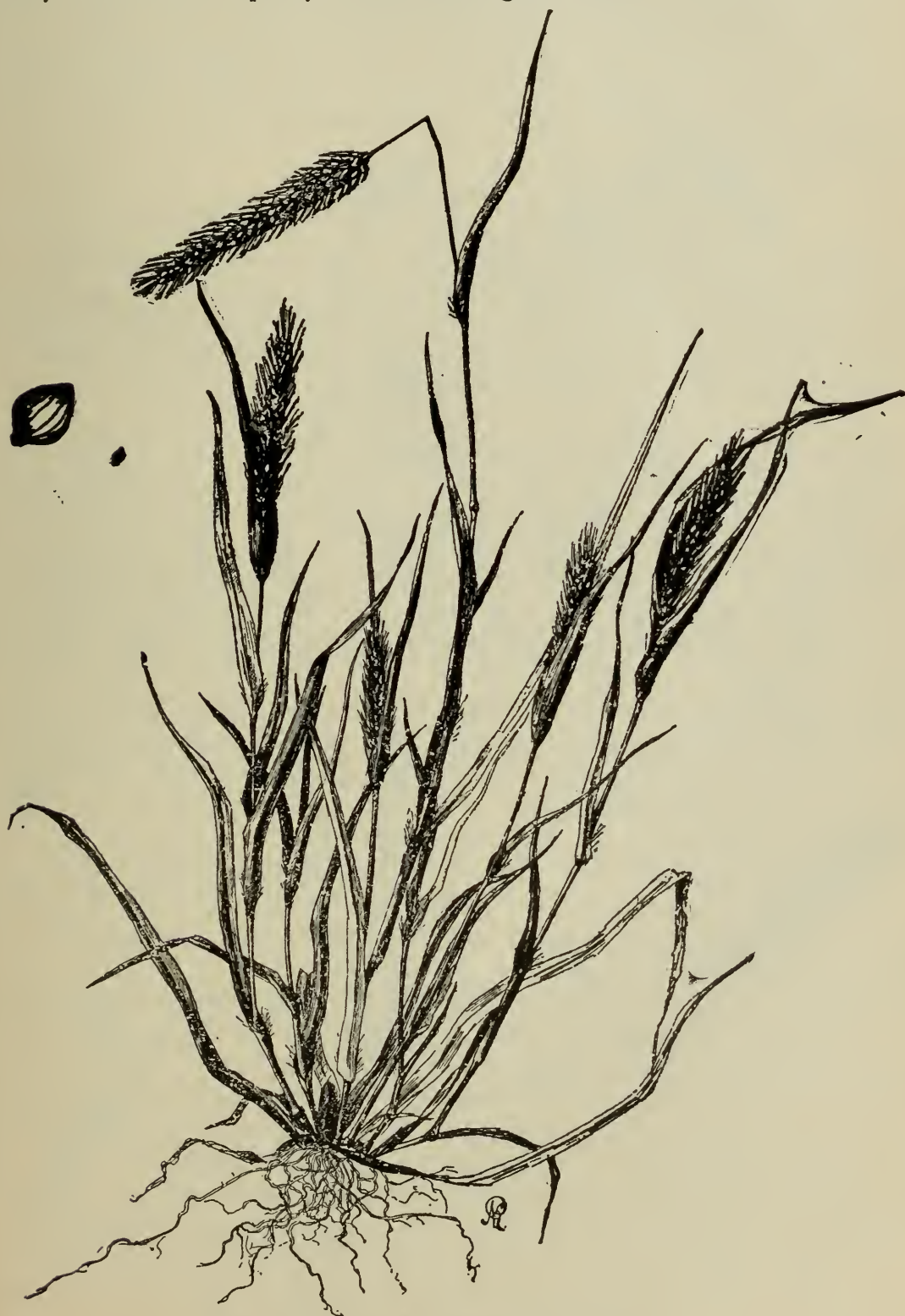


Fig. 1. Green Foxtail (*Setaria viridis*).

Time of flowering, July to September.

Time of seeding, August to October.

Control. Gang-plow stubble land about three inches deep early in the fall. As soon as the seeds have had time to sprout cultivate thoroughly. Repeat cultivation and rib the land with a double mould-board plow last thing before frost. If the field is very badly infested with fox-tail put in a hoed crop (potatoes, roots or corn) next spring, and cultivate thoroughly throughout the growing season. Follow with a grain crop seeded with clover, without plowing after the roots. *"Thick seeding with clover and grasses will help to suppress fox-tail in autumn stubble and subsequent clover crop. In clover seed crops the patches that have been winter-killed should be mown while the fox-tail is still quite green. The cut this time may be of value for fodder and the increased market value of the clover seed will more than repay the cost of labour. Any practice that will prevent this annual from seeding will reduce and ultimately eradicate it."

YELLOW FOXTAIL (*Setaria glauca* (L) Beauv.)

A grass very similar to green foxtail and found in similiar situations. It can however, be distinguished from green foxtail by the less dense spike and the larger spikelets, surrounded by tawny yellow bristles. The seeds are larger than those of the green foxtail usually brown in colour and with very distinct cross ridges.

Control. The same as for green foxtail.

CHESS, CHEAT OR WHEAT THIEF (*Bromus secalinus*, L.) (Fig. 2.)

This is a weedy grass naturalized from Europe. It is a winter annual of from three to four feet high, with fibrous roots and rough, coarse leaves. The spikelets are large, dark green in colour and in loose panicles.

The seeds are straw coloured, somewhat boat shaped, the back being rounded. They are about $\frac{1}{3}$ of an inch long and one face is deeply creased and has a row of spines near each margin. They possess great vitality and are often found among wheat and rye.

Many look upon Chess as degenerated wheat, because it appears among fall wheat that has been winter-killed. This idea is erroneous and without foundation. The fact is that Chess will mature seed under adverse conditions, even though the plant be only a few inches high.

Time of flowering, June. Time of seeding, July.

"Chess is a typical plant belonging to the genus *Bromus*. Wheat belongs to the genus *Triticum*. Chess will produce Chess and only Chess, and a seed of wheat cannot be sown to produce Chess, and Chess cannot produce wheat under the most favourable conditions of growth.

"In instances where parts of a plant, apparently a combination of Chess and wheat, were so united as to seem but one plant, close examination proved them to be parts of separate plants, and that the apparent union was not real."

Control. Avoid sowing Chess in seed grain. The seed is comparatively short-lived, and a four-years' rotation exclusive of winter grain will clean it out of the soil. Patches in grain fields should be cut down before the plants mature their seeds. Thick seeding with early red clover is recommended for badly infested fields. The first crop of hay should be cut before the Chess has had an opportunity to produce seeds.

If a field is badly infested with Chess, plow the land two or three inches deep as soon as possible after the grain crop has been removed. Then work it up fine with

the use of the roller and the harrow to conserve the moisture so that a large percentage of the Chess will be encouraged to germinate. In two or three weeks cultivate with a spring-toothed cultivator and harrow well. Continue to cultivate or disk the land frequently until the late fall, when it should be plowed deeply in order to bring the lower section of the soil to the surface.

Early in the spring thoroughly stir the surface soil with the cultivator and harrow. In about two weeks cultivate or disk and sow barley or other spring grain, seeding down with red clover or alfalfa.

If it is desired, fall wheat may be sown instead of the spring grain. In that case the land should be summer fallowed until time to sow the wheat. The summer fallow must be well cultivated and kept clean, and the wheat should not be sown until the middle of September.

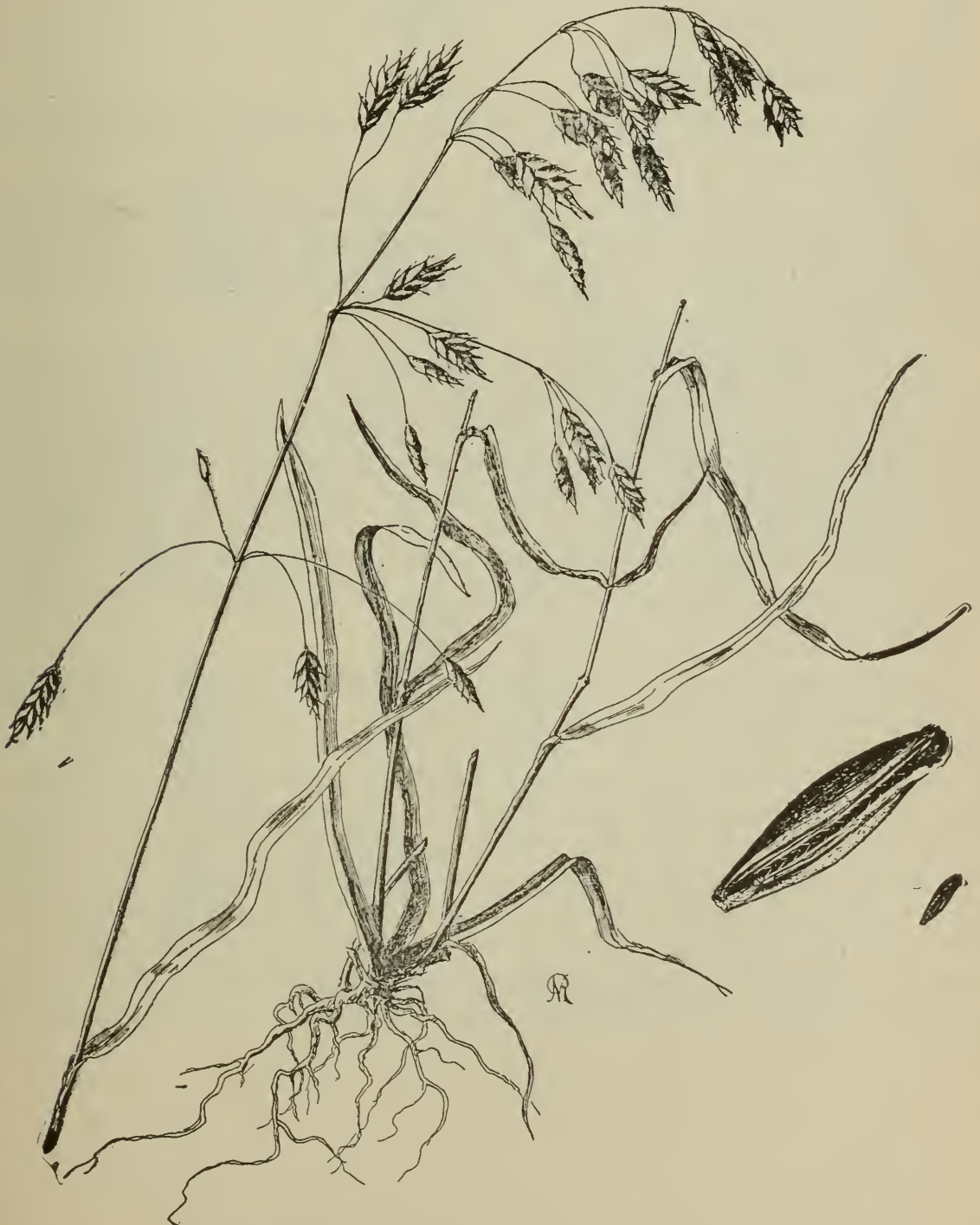


Fig. 2 Chess (*Bromus secalinus*).

WILD OAT (*Avena fatua*, L.) (Fig. 3.)

An annual weed with erect and smooth stems. The leaves and stems are covered with white bloom, which give a peculiar white-green colour to the whole plant. The head forms a loose panicle, with nodding and spreading branchlets. The awn is long and bent. It is bent most when dry; but if moistened, it uncoils and wriggles around, thus causing the seed to move appreciable distances.

The principal points of difference between the wild and cultivated oats are (1) In the former the chaff is thick and hairy while in the latter it is thin and hairless; (2) The wild oat has a long, stiff awn which is bent and twisted when dry while the cultivated oat either has a much smaller and less stiff awn or none at all; (3) The wild oat has a sucker mouth scar at the base which is not present on a cultivated oat.

Time of flowering, July.

Time of seeding, July-August.

Dispersal—Conveyed from place to place by threshing machines, and as an impurity in seed-grain.

Wild oats are at home in any soil that will grow cereals, and they ripen their seeds among almost any cereal crop. The seeds possess wonderful vitality, some of them remaining buried in the soil for years and germinating as soon as they are brought under favourable conditions.

Control. On a field infested with wild oats, cereal crops should be dropped out of the rotation as far as possible; and hoed crops, soiling crops, hay, and pasture should take their place. To get the land under grass, it should be fallowed during part of the season, the cultivation being frequent and shallow to destroy all seeds that may have germinated in the upper layer of the soil. The land can then be sown with winter wheat and seeded, or with an early variety of barley, which should be cut on the green side. The treatment mentioned is suitable for pasture land, or land which has produced a hay or soiling crop during the fore part of the season. Two hoed crops in succession will do much to exterminate this pest.

Plow the ground early in the spring, or if it has been plowed the previous fall, cultivate well and harrow the soil down fine in order to germinate the oats. When they have got well started disc or cultivate a second time. About the last week in May or the first of June apply a good coating of manure and plant corn in hills so that it can be cultivated both ways. Keep the corn well cultivated and hoe out any oats that may come up in the hills. When the crop is harvested plow seven or eight inches deep. The next spring repeat the early cultivation until it is time to plant another crop of corn, potatoes, rape or turnips. If this second cultivated crop is well looked after and kept clean nearly all the wild oat seeds will be germinated and destroyed. Follow this hoed crop with an early variety of barley, seeding down to red clover or alfalfa, and you will have a good chance to get rid of any wild oats that remain.



Fig. 3. Wild Oats (*Avena fatua*).

COUCH-GRASS, TWITCH-GRASS, QUACK-GRASS, OR QUICK-GRASS;

ALSO WHEAT-GRASS (*Agropyron repens*, (L.) Beauv.) (Fig. 4.)

Couch-grass is a creeping perennial which grows from 1 to 3 feet high. It has a jointed root-stock which penetrates deeply into the ground and possesses great vitality. The plant produces spikes from 3 to 8 inches long. The small spikelets alternate at each notch of the flower stalk, with the side of the spikelets turned towards the stalk.

The seeds are about one-half inch long and rather slender. (Fig. 4.) An average plant produces 400 seeds.

Time of flowering, June-July.

Time of seeding, July-August.

Dispersal—The root-stocks are carried around by implements, and the seeds are dispersed in seed-grain, the coarser grass seeds, straw and manure.

Whatever value Couch-grass may have for pasture, its habit of taking and keeping possession of the soil renders it extremely objectionable. It flourishes best in loamy or humus soils, from which it is especially difficult to eradicate.

Control. The use of rape in the destruction of Twitch Grass: Cultivate the field until about the middle of June, running over it frequently with the cultivator so as to keep the tops down and thus weaken the "roots." Then apply manure at the rate of about twenty tons per acre (twelve good loads.) Cultivate the manure in thoroughly, and with a double mould board plow, slightly ridge up the land, making the ridges about 26 inches apart. On the ridges sow pasture rape at the rate of 1½ pounds per acre. It is important that the right amount of rape should be sown, for if too little is sown the stand will not be thick enough to smother the Twitch Grass, and on the other hand, if too much is sown, the plants will be too crowded and not grow vigorously enough to keep ahead of the weed. Sow the rape when the land is sufficiently moist to insure quick germination of the seed. If the rape is slow in starting, the Twitch Grass may get a start in the rows and thus necessitate hand cultivation there. Cultivate the rape every week or ten days until it occupies all the ground and makes further cultivation impossible. If, when the rape is cut or pastured, any Twitch Grass remains, the field should be ridged up the last thing in the fall and a hoed crop put in the following year. This should not be necessary if a good stand of rape is secured.

Method of cultivation for the destruction of Twitch Grass: If the field is under crop, as soon as this is harvested, plow lightly, then harrow with the ordinary harrow, and if necessary cultivate with a spring tooth cultivator. This shakes the Twitch Grass "roots" free from the soil and makes it possible to gather them up with a horse-rake. Burn as soon as they have dried sufficiently. Repeat this process two or three times. If the weather at this time should happen to be dry and hot, so much the better. Later in the fall rib up the land and allow it to stand over winter. The frost in all probability will render material assistance in the eradication. The following spring plow it about the end of May, cultivate well and put in some hoed crop, or summer fallow, sowing buckwheat, the crop to be plowed under. The hoed crop or summer fallow must be thoroughly cultivated if this method is to be successful.

If the field in which the Twitch Grass is troublesome is in meadow or pasture, first let the plant exhaust its substance by the production of a hay crop, which should be cut and removed as soon as the head is formed and before it is in bloom. Then plow shallow and cultivate as described above until the "roots" have been brought to the surface. When brought to the surface the "roots" should be gathered and burned

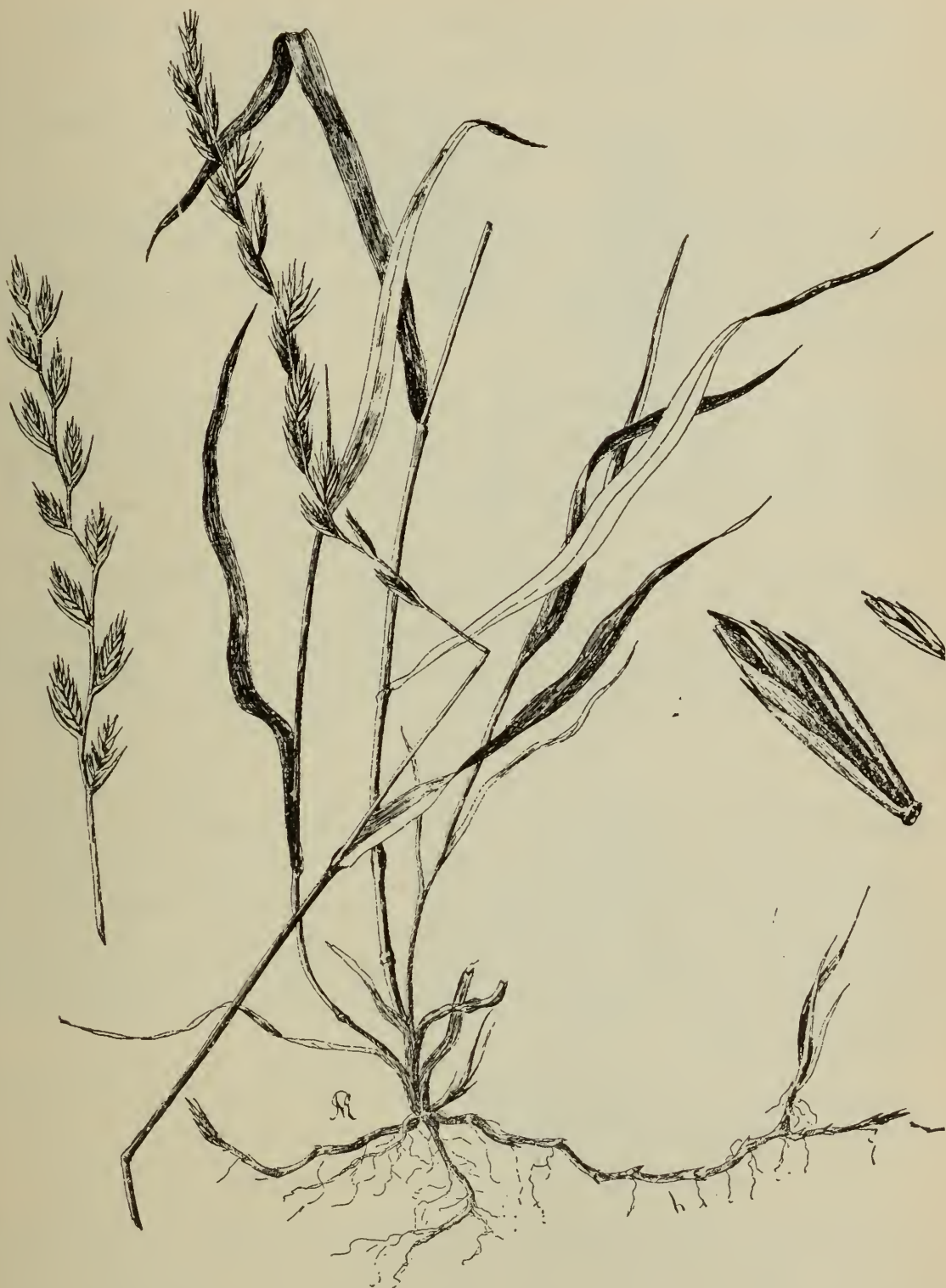


Fig. 4. Couch Grass on right of figure and part of a stalk of perennial Rye-grass (*Lolium perenne*) on left. Note the arrangement of spikelets in the Rye-grass.

or removed. This should be done before the plant has an opportunity to renew its growth. Then sow rape, buckwheat or millet and the following year put in a hoed crop (corn, potatoes or roots).

SKUNK-TAIL GRASS, WILD BARLEY, OR SQUIRREL-TAIL GRASS

(*Hordeum jubatum*, L.) (Fig. 5.)

This grass is very troublesome in the West, and is now quite frequently found in many parts of Ontario, especially along railways.

A native perennial grass forming tufts from 8 to 12 inches high. Leaves are pale green in colour, from 3 to 4 inches long with rough margins. Flowers are in a silky, bristly spike, from 3 to 4 inches long, pale yellowish green in color. The seed is slender, sharp-pointed, somewhat resembling a small barley seed, and has a long upwardly barbed awn. (Fig. 5.)

Control. Cut the plants whenever they appear in waste places, and thus prevent them from going to seed and spreading. This weed is not troublesome in fields under cultivated crop. Cut patches of it in meadows just as soon as it ears out. This will not injure the other grasses in the meadow.

OLD WITCH GRASS OR TUMBLE GRASS (*Panicum capillare*, L.)

An annual grass, very common in neglected hoed crops, gardens and waste places. Plants stout, with hairy leaves and large, finely branching, loosely spreading tops (panicles) which are often seen rolling over the ground on windy days in the fall of the year.

BARNYARD GRASS OR COCKSPUR GRASS (*Echinochloa crusgalli*, (L.) Beauv.)

This grass is often abundant in hoed crops, headlands and waste places. The seed occurs occasionally in commercial seeds. A coarse annual grass from 1 to 3 feet high with broad leaves. Inflorescence 1 to 3 inches long, consisting of several one-sided branches crowded together and bearing numerous short-awned spikelets. Seeds dark green to brown, flat on one side, round on the other, one-eighth inch long, very smooth and shining.

Control. Proper cultivation of hoed crops and taking care to cut in waste places before it seeds will cause it to disappear.

FINGER GRASS OR CRAB GRASS (*Digitaria sanguinalis*, (L.) Scop.)

A troublesome grass in lawns and sometimes in low fields. A much branched, leafy annual, from 10 inches to 2 feet high, spreading on the ground and frequently rooting at the lower joints of the stem. The leaves are from 2 to 4 inches long with rough margins. Flowers are produced in spikes which come off from the stem like the fingers on the hand, hence the common name, Finger Grass.

Control. A much harder grass to eradicate than the Foxtails, because it roots so readily at the joints. Repeated cultivation after harvest, will do much to destroy it. Spud out patches in lawns and stir the soil with a rake and sow heavily with pure lawn grass seed when the ground is moist.

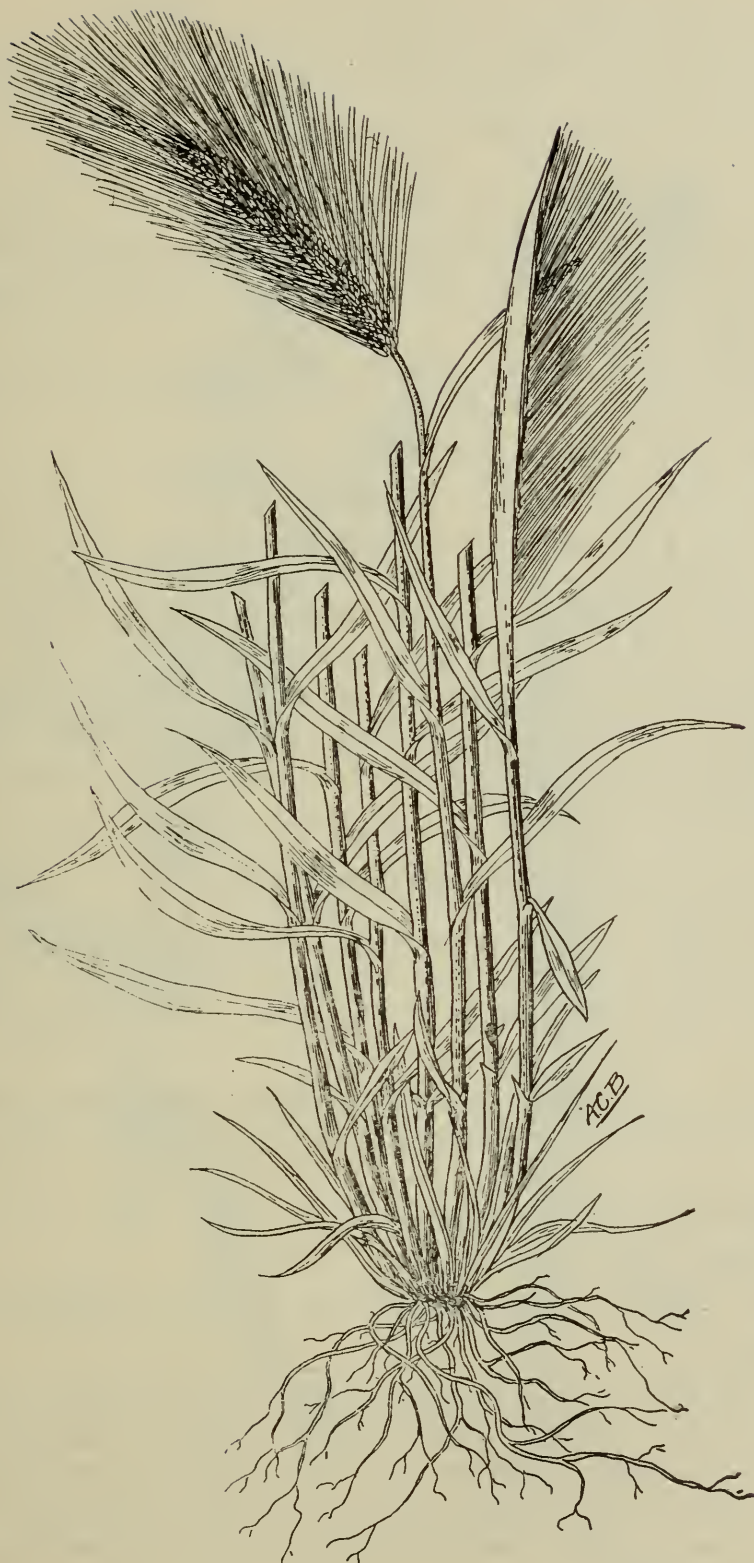


Fig. 5. Skunk-tail Grass (*Hordeum jubatum*).

THE BUCKWHEAT FAMILY (*POLYGONACEAE*)

DOCK, CURLED DOCK, SOUR DOCK, OR YELLOW DOCK (*Rumex crispus*, L.) (Fig. 6.)

A deep-rooted perennial weed introduced from Europe.

It occurs around buildings, in neglected lanes, along waysides and in pastures. The stem is quite slender, and the leaves are from 6 to 12 inches long, with wavy margins; hence the common name, "curled dock." The flowers are in racemes, green in colour.

The seed is covered by a winged husk and is carried considerable distances by the wind. The manner of attachment of the seed to the wing is shown in illustration (Fig. 6). The seeds are light brown in colour and beech-nut shaped. They are smooth and shiny.

The wind acts as an agency in scattering the seed, and it is a very common impurity in clover and other seeds used on the farm.

An average plant produces about 17,000 seeds.

Time of flowering and seeding, July-August.

Control. Sow pure seed only. Put the land under a short rotation of crops which allows for the frequent introduction of hoed crops. The later sown hoed crops such as rape are more effective than those sown earlier in the season. Keep the land clean by frequent cultivation until it is time to put in the hoed crop. In meadows or pastures pull the dock when the soil is soft after rain. Pull or cut before seeding any docks that may be seen in the clover seed crop. In lawns or pastures when the ground is too hard and dry to permit pulling the dock cut them off below the ground and apply a heavy coating of coarse salt.

SORREL, OR SHEEP SORREL (*Rumex acetosella*, L.) (Fig. 7.)

A perennial with running root-stocks. The stem is slender and erect with branches. The leaves are spear-shaped and quite characteristic. The flowers occur in racemes and are green to greenish red in colour. The foliage has a pronounced acid taste.

The seed is $\frac{1}{16}$ inch long, triangular, smooth, and shining when naked, but dull brown when invested by its covering. An average plant produces about 10,000 seeds.

Time of flowering, June-September.

Time of seeding, July-October.

Propagation—By its running root-stocks, and as an impurity in clover seed, especially Alsike.

Control. Sorrel is usually an indication of a poor, sandy, or gravelly soil. It prefers acid soils, hence liming and manuring are effective remedies when the land is well tilled. The remedies given for the Dock (Fig. 6) are applicable to Sorrel, only it requires more frequent use of the broad-shared cultivator, which should be used so as to cut the roots just below the surface of the soil, without bringing up any of the creeping root-stocks.

LADY'S THUMB, OR SMARTWEED (*Polygonum persicaria*, L.)

This plant grows to a height of 12 to 18 inches. Its leaves are lance-shaped, usually with a dark blotch near the centre. It is an annual and is often abundant.

Control. Prevent from seeding, and sow clean seeds.

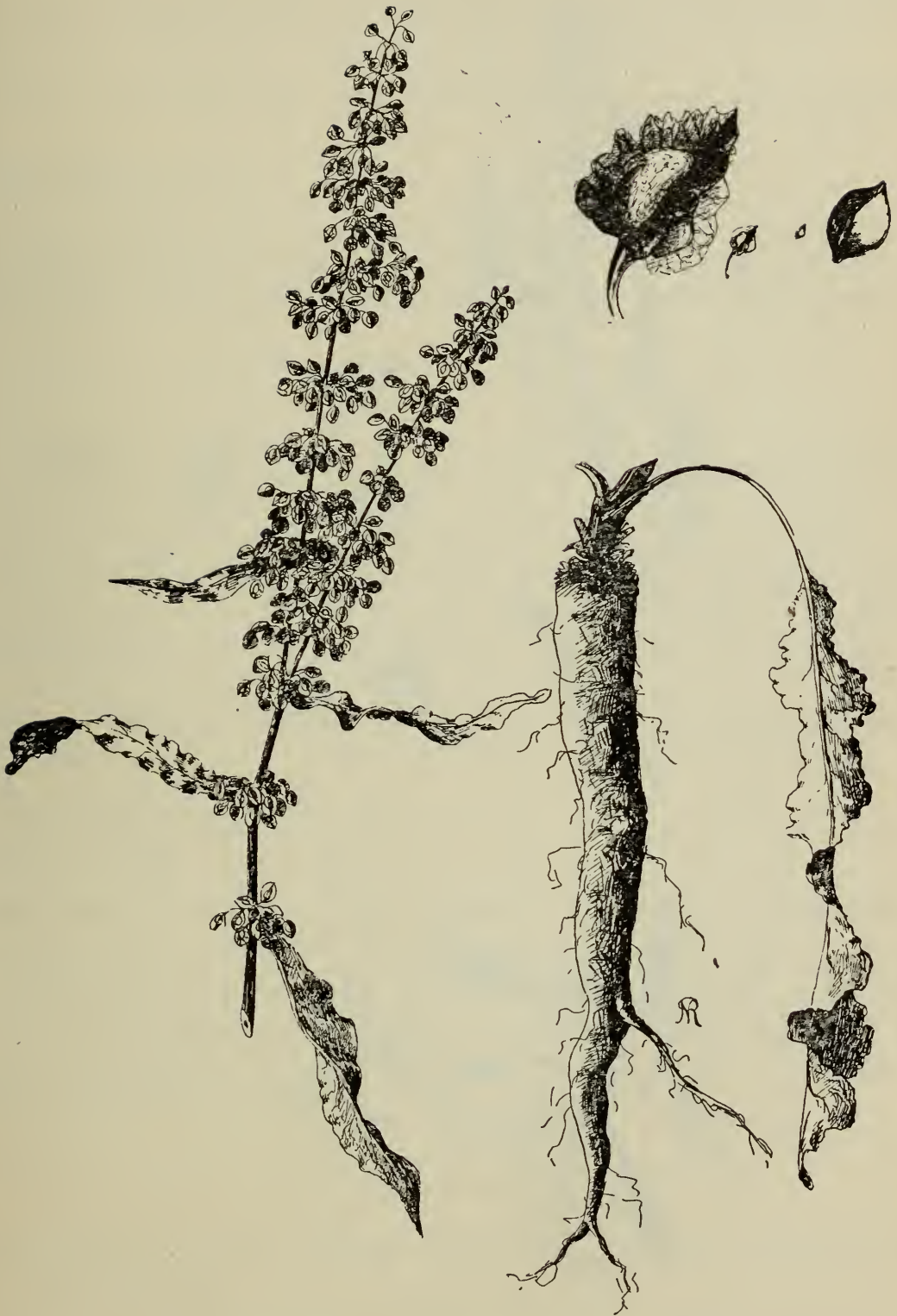


Fig. 6. Curled Dock (*Rumex crispus*).

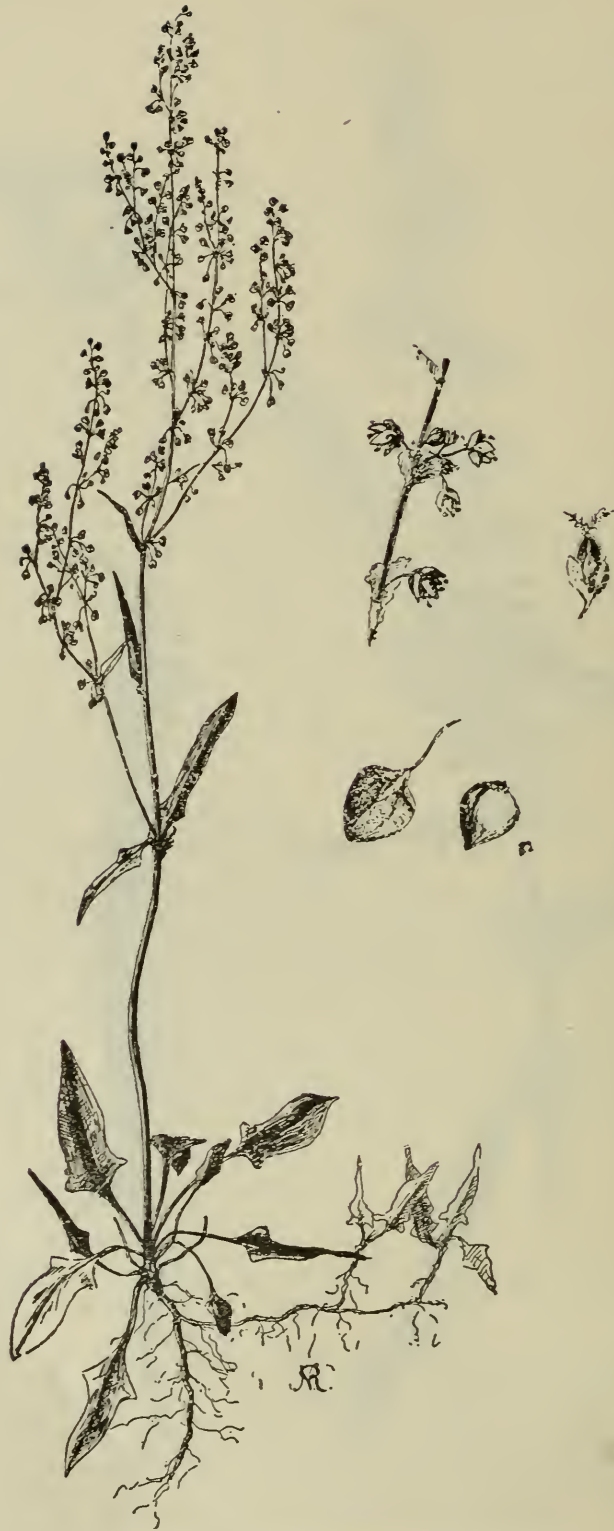


Fig. 7. Sheep Sorrel (*Rumex acetosella*).

WILD BUCKWHEAT OR BLACK BINDWEED (*Polygonum convolvulus*, L.) (Fig. 8.)

An introduced annual weed found commonly in cereal crops throughout Ontario. It is a twining herb with branching stems and thin smooth arrow-shaped leaves; flowers small, inconspicuous, greenish in clusters in the axils of the leaves, and at the end of the stems. Seeds black, often covered with a brownish "husk" buckwheat-shaped, about $\frac{1}{8}$ of an inch long, but when found in grain the outer black hull is often missing, and the seed is then white and waxy in appearance.

Time of flowering, from June to September; seeds ripen about the middle of July.

Dispersal—By seeds.

Control. Watch for the seeds of Wild Buckwheat in your seed grain. Cultivate lightly immediately after harvest and cause the seeds to germinate, then harrow out the young plants. Harrow grain crops lightly when the grain is about 3 inches high.

THE SPINACH OR GOOSEFOOT FAMILY (*CHENOPODIACEAE*)

LAMB'S QUARTERS, OR GOOSEFOOT (*Chenopodium album*, L.) (Fig. 9.)

An annual weed widely distributed in cultivated land. It grows to a height of from 2 to 6 feet. The stem is grooved and much branched. The leaves are whitish-green below and dark green above. The flowers are inconspicuous and greenish in colour.

The seed (Fig. 9) is black and shining, lens-shaped and round, about $\frac{1}{16}$ of an inch in diameter.

Time of flowering, June-October.

Time of seeding, August-October.

Distribution—By seeds, especially as an impurity in clover and grass seeds.

Control. Late cultivation is especially necessary in combating this weed, as it flowers and seeds till very late in the season. The land should be gang-plowed shallow and harrowed immediately after the harvest, and cultivated at intervals until late in the fall, when it may be plowed or ribbed up for a hoed crop the following spring. Subsequent treatment the same as for Foxtail (Fig. 1).

Oak-leaved Goosefoot. Usually spreads on the ground. Its leaves are like minute white oak leaves.

Maple-leaved Goosefoot. Grows erect, with large, thin, triangular leaves.

Strawberry Blite. Resembles the last, but has red seed clusters.

Spreading Orache. Somewhat resembles Lamb's Quarters, but has larger and thicker leaves, goosefoot shaped. It is much branched or spreading and the seed covers are warty.



Fig. 8. Wild Buckwheat (*Polygonum convolvulus*).



Fig. 9. Lamb's Quarters (*Chenopodium album*).

RUSSIAN THISTLE (*Salsola kali*, var *tenuifolia*, G. F. W. Mey) (Fig. 10.)

This is a weed which has appeared on many farms in Ontario, but does not appear to have become established in cultivated fields. It has been introduced as an impurity in Alfalfa seed. The Russian Thistle is a very serious pest in several of the Western States, and is found in the Prairie Provinces, but has not yet been reported as being very troublesome there. The plants, when ripe, break off at the surface of the ground and are rolled long distances by the wind, scattering their numerous seeds on their journey. It is this tumbling habit that makes this weed particularly adapted to the prairie lands of the West, and it probably will never be a serious pest in Ontario, where fences, trees and other obstructions will prevent its being spread far and wide by the wind.

Description. The Russian Thistle is a native of Europe and Western Asia. It is a nearly-smooth, bushy-branched annual, from 1 to 3 feet high. Mature plants are

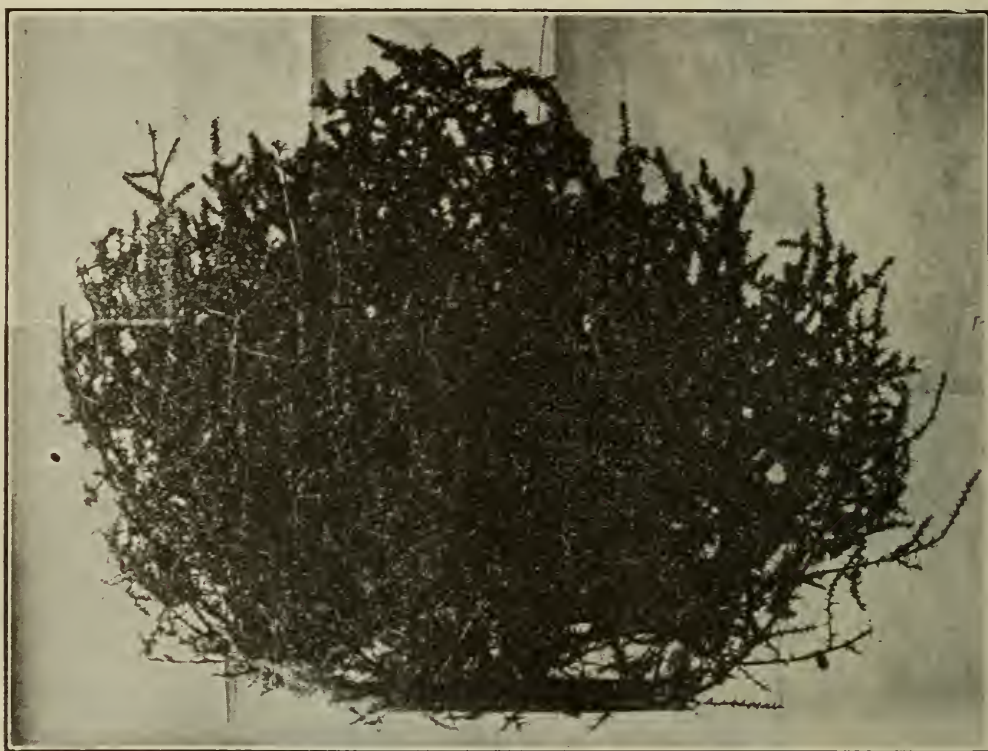


Fig. 10. Russian Thistle.

more or less spherical in form. The stems and branches are red in colour. The leaves are awl-shaped, 1 to 2 inches long, soft and fleshy when young, very prickly pointed when mature. The flowers are inconspicuous, being small, without petals, and solitary in the axils of the leaves. The seeds are about $\frac{1}{12}$ of an inch long, obconical in general outline, with a cup-shaped depression at the upper end, in the centre of which is a pointed projection; colour dull grey or green, embryo spirally coiled.

Control. The Russian Thistle, being an annual weed, is not hard to exterminate. If once cut off at the surface of the ground it never grows again, and hence in well cultivated fields it is not likely to prove a pest. The chief danger lies in neglect. A single plant produces an enormous number of seeds, and if a few specimens are allowed to mature they will seed down a whole field and cause serious trouble the following year, especially in a crop which does not allow of the frequent use of the cultivator. Farmers in Ontario should, therefore, be on the lookout for



Fig. 11. Pigweed (*Amaranthus retroflexus*).

this weed and destroy any specimens they may find in their fields, fence corners, or along the road sides.

THE PIGWEED FAMILY (*AMARANTHACEAE*)

PIGWEED, OR REDROOT (*Amaranthus retroflexus*, L.) (Fig. 11.)

An annual, with a pink root, stout erect stem and many branches. It grows from 1 to 6 feet high. The leaves are light green in colour and ovate in shape. The flowers are in dense spikes which terminate in branches or are from the axils of the leaves. They are inconspicuous, green in colour, and surrounded by chaff like scales.

The seeds (Fig. 11) are egg-shaped, black, smooth and shiny. The average plant produces about 15,000 seeds.

Time of flowering, July-September.

Time of seeding, August-October.

Dispersal—The seed is distributed by the wind and as an impurity in grass seed.

Control. Special attention must be given to fall cultivation of the soil so as to prevent plants from ripening, and to sprout and destroy the seeds which have fallen upon the ground. The land should be gang-plowed shallow and harrowed immediately after harvest, and cultivated at intervals until late in the fall, when it may be plowed or ribbed up for a hoed crop the following spring. Subsequent treatment the same as for Foxtail (Fig. 1).

Tumble Weed, or White Pigweed (*Amaranthus graecizans*, L.). This plant resembles Russian Thistle quite closely, but can be distinguished from it by its round, shiny, jet-black seeds, and by its leaves, which, although small, have a definite blade. It is a low-branched annual when growing in sandy, open fields and roadsides.

Control. Prevent the maturing of the seeds, which ripen in August. The plants as a rule are conspicuous, and may be readily collected and *burned*. The seeds are often found in grass seed mixtures.

Spreading Amaranth (*Amaranthus blitoides*, Wats.) forms large mats on waste ground, along roadsides and walks.

THE PINK FAMILY (*CARYOPHYLLACEAE*)

CORN SPURREY (*Spergula arvensis*, L.) (Fig. 12.)

This is an annual weed introduced from Europe. It is found chiefly on sandy soil. It grows from 15 to 18 inches high. The flowers are small, white, and in loose, terminal clusters. The leaves are needle-like in whorls at the joints of the stem. The seeds are dull black, mottled with brown, round and flattened, with the margin extending into a narrow rim.

Time of flowering, July; seeds ripen, July to August.

Dispersal—By seeds.

Control. Spurrey does not give serious trouble when a systematic rotation of crops is followed. Early after harvest cultivation will do much to rid the land of Spurrey. Seedling plants in spring grain can be destroyed by application of the weeder or harrow.

CORN COCKLE, OR PURPLE COCKLE (*Agrostemma githago*, L.) (Fig. 13.)

An annual introduced from Europe, about 1 to 3 feet high, with erect habit of growth. It has but few branches and the stems are all very hairy, with whitish-green hairs. The leaves are rather long and narrow, with pointed ends. The flowers are red to purple, and the flower cup, calyx, has long lobes, three or four times the length of the petals.

The seed capsules are generally well filled with seed, which is black in colour and irregularly kidney-shaped, with tubercles (small conical projections) arranged in rows around the sides of the seed. (See Fig. 13). The seed is about $\frac{1}{8}$ of an inch across. An average plant produces about 500 seeds.

Time of flowering, July.

Time of seeding, August.

Dispersal—By birds, in manure, and as an impurity in seed.

It may be noted, in passing, that the seed is injurious to young chickens, and the husks of the seed often elude the miller and appear as black specks in flour, which is seriously damaged thereby. An old writer Gerarde, says:

“What hurt it doth among corn (wheat), the spoyle unto bread, as well in colour, taste, and unwholsomeness, is better known than desired.”

Control. Sow clean seed; and when the weed is not very thick pull it by hand. Practice a short rotation of crops. Cultivate thoroughly after harvest. If this weed is very abundant fall wheat should be omitted from the rotation for four years.



Fig. 12. Corn Spurrey (*Spergula arvensis*).



Fig. 13. Corn Cockle (*Agrostemma githago*).

BLADDER CAMPION, COW BELL OR BLADDER WEED (*Silene latifolia*, (Mill),
Britten & Rendle.) (Fig. 14.)

This weed has become a serious pest on many farms in Ontario. It is dispersed by seeds and root stocks. The seed is one of the commonest impurities in clover seeds, especially red clover. As it is a free seeder and very difficult to exterminate once it becomes established, too much care cannot be taken to secure clover seed free from this impurity, and to dig up by the roots and burn any stray specimens that by any means may find their way on to the farm.

Description. The Bladder Champion is a naturalized, deep-rooted, freely-branching, perennial weed belonging to the Pink Family (*Caryophyllaceae*). It grows from 6 inches to 2 feet high. The leaves are ovate lanceolate, smooth, in pairs, with their bases meeting around the stem. The flowers are white, nearly an inch in diameter, and borne in loose clusters, which are often drooping. The petals are two-cleft and the calyx much inflated and bell-shaped, with distinct purplish veins. It is from the inflated calyx that the plant derives its common names, Bladder Champion, Bladder Weed and Cow Bell. The capsule or "seed pod" is enclosed by the inflated calyx, and opens at the top by 3 to 6 recurved teeth. This weed flowers from June to August, and matures seed from July to October. Large quantities of seed are produced. They are about $\frac{1}{16}$ of an inch in length, irregularly kidney-shaped, light brown to dark grey in colour, the surface covered with regularly arranged rows of tubercles. Typical seeds show a marked depression at the scar. This character, and the more conical shape of the tubercles, make it possible for a careful observer to distinguish them from the seeds of the Night-flowering Catchfly and White Cockle, which they resemble very closely.

Time of flowering, June to August.

Time of seeding, July to October.

Control. The roots of this pest are very long, thick, and much branched. A good-sized plant will have a root over two feet long, with numerous deep root-stocks. A weed with such an underground root system is necessarily hard to combat. Some means must be taken by which the deep roots and rootstocks can be destroyed. Small patches should be carefully dug out early enough in the season to prevent seeding, taking pains to get every piece of the root and rootstocks. Badly infested fields should be plowed deeply immediately after harvest; and then thoroughly cultivated and cross-cultivated with the broad-shared cultivator in order to cut up and weaken the underground root system. The following spring continue the deep cultivation at intervals of about two weeks until it is time to put in a hoed crop, which must be kept thoroughly clean in order to be effective. Corn, following thorough cultivation as above, has been found to be an excellent hoed crop with which to fight this weed.

WHITE COCKLE, EVENING LYCHNIS, OR WHITE CAMPION (*Lychnis alba*, Mill.)
(Fig. 15.)

This is a biennial or short-lived perennial weed introduced from Europe. It is a very hard weed to get rid of once it becomes established on a farm. It is much more troublesome than Night Flowering Catchfly. The roots of mature plants are large and fleshy, the stems branching, from 1 to 3 feet high. The leaves are ovate, lanceolate with acute tips. The whole plant is hairy and sometimes slightly sticky. The



Fig. 14. Bladder Campion (*Silene latifolia*).



Fig. 15. White Cockle (*Lychnis alba*).

flowers are in a loose cluster, white or pink in colour and about $\frac{3}{4}$ of an inch across. They are dioecious, that is, all the flowers on some plants have stamens only, while all the flowers on other plants have pistils only. The seed pod when mature has ten little teeth at the top.

Time of flowering, June to August.

Time of seeding, July-September.

Dispersal—By wind and as an impurity in seeds.

Control. A persistent weed that is difficult to eradicate. Exercise great care in the cleaning of seed grain and examine all purchased grain and clover for the seed of this weed. A bare summer fallow with thorough cultivation will do much to suppress it. The roots are fleshy and hard to kill unless dragged right up to the surface of the soil. If there is a little earth covering any part of them they will continue to grow and produce seed. When spudded below the surface they will grow again but do not produce seed that season. A short rotation of crops will keep it in check. Discing bare stubble will help to prevent it from seeding late in the season. Thick seeding with clover will restrict it by smothering. Pastures following a single cut of early clover should be trimmed with a mower about the middle of August to prevent the maturing of the seed.

NIGHT FLOWERING CATCHFLY, OR STICKY COCKLE (*Silene noctiflora*, L.)

This is an annual or winter annual which resembles somewhat closely White Cockle. It can be distinguished from White Cockle by the smaller roots, by the sticky feel of the young plants due to the abundant glandular hairs, by the flowers which contain both stamens and pistils, and by the seed pod which has six teeth at the top.

Time of flowering, June to frost.

Time of seeding, July to frost.

Dispersal—As an impurity in clover and grass seeds.

Control. Be sure that all grass and clover seed sown is free from the seeds of this weed. Adopt a short rotation of crops. Hand pull from alsike fields before cutting the seed crop. If an alsike field is so badly overrun with this weed as to make hand pulling impracticable cut it early for hay and rake it up and put under cultivated crop for a year or two.

COW COCKLE, OR COW HERB (*Saponaria vaccaria*, L.)

A weed common in grain fields in the West. The seed is often found in grain from the West. During the past few years it has been found in many parts of Ontario, but has not yet become a serious pest in this Province. It is a smooth, glaucous, annual plant, from 1 to 2 feet high. The leaves are oval lance-shaped, opposite, and clasp the stem at the base. Flowers are bright pink, about $\frac{1}{2}$ inch in diameter. Seed pod is enclosed in the inflated, 5-angled calyx, and contains about 20 black spherical seeds about $\frac{1}{12}$ inch in diameter, with the surface minutely pitted.

Time of flowering, July; seeds ripe in August.

Dispersal—By seeds only.

Control. The plant being conspicuous, is easily hand pulled. Fall and spring cultivation will do much to clean badly infested fields.

PURSLANE FAMILY (*PORTULACACEAE*)

PURSLANE, OR PURSLEY (*Portulaca oleracea*, L.) (Fig. 16.)

Purslane is pre-eminently a garden weed, and is easily recognized by its fleshy leaves and stem, which lie prostrate on the ground. It is an annual.

The stems are red, and the leaves wedge-shaped and clustered at the ends of branches. The flowers are bright yellow, about $\frac{1}{4}$ inch across, and open only during full sunlight for a few hours in the morning. The seeds (Fig. 16), in small capsules, are black, kidney-shaped, and extremely small. An average plant produces 60,000 seeds.

Time of flowering, July to frost.

Time of seeding, August, until frost.

Dispersal—By seeds.

Purslane has been used as hog feed in very dry seasons, but the cost of gathering it is too great.

Control. Careful hoeing and constant cultivation. The latter should be as early as possible. Plants which have been hoed out should be raked up and destroyed or they will mature the seeds.

THE BUTTERCUP FAMILY (*RANUNCULACEAE*)

TALL BUTTERCUP, TALL CROWFOOT, MEADOW BUTTERCUP (*Ranunculus acris*, L.) (Fig. 17.)

A noxious weed in low meadows and pasture lands. It crowds out the grass, and cattle will not eat it on account of its hot tasting, blistering juice. It is seldom troublesome on well-drained land under a short rotation of crops.

An introduced perennial weed with fibrous roots and an erect, somewhat hairy stem. The leaves are three-parted, with the divisions again three-cleft with deeply lobed segments. Flowers are produced from early in June until frost. They are bright yellow in colour and conspicuous. The dry seed-like fruits are in globose heads.

Time of flowering, June to frost; seed ripe by July.

Dispersal—By seeds.

Control. When possible the land should be well drained and brought under cultivation, and not seeded down again until the weed has disappeared. On pasture lands which cannot be cultivated the weed should be cut closely two or three times each year; once early in June and again in July or August. This treatment to be successful must be repeated for two or three years.

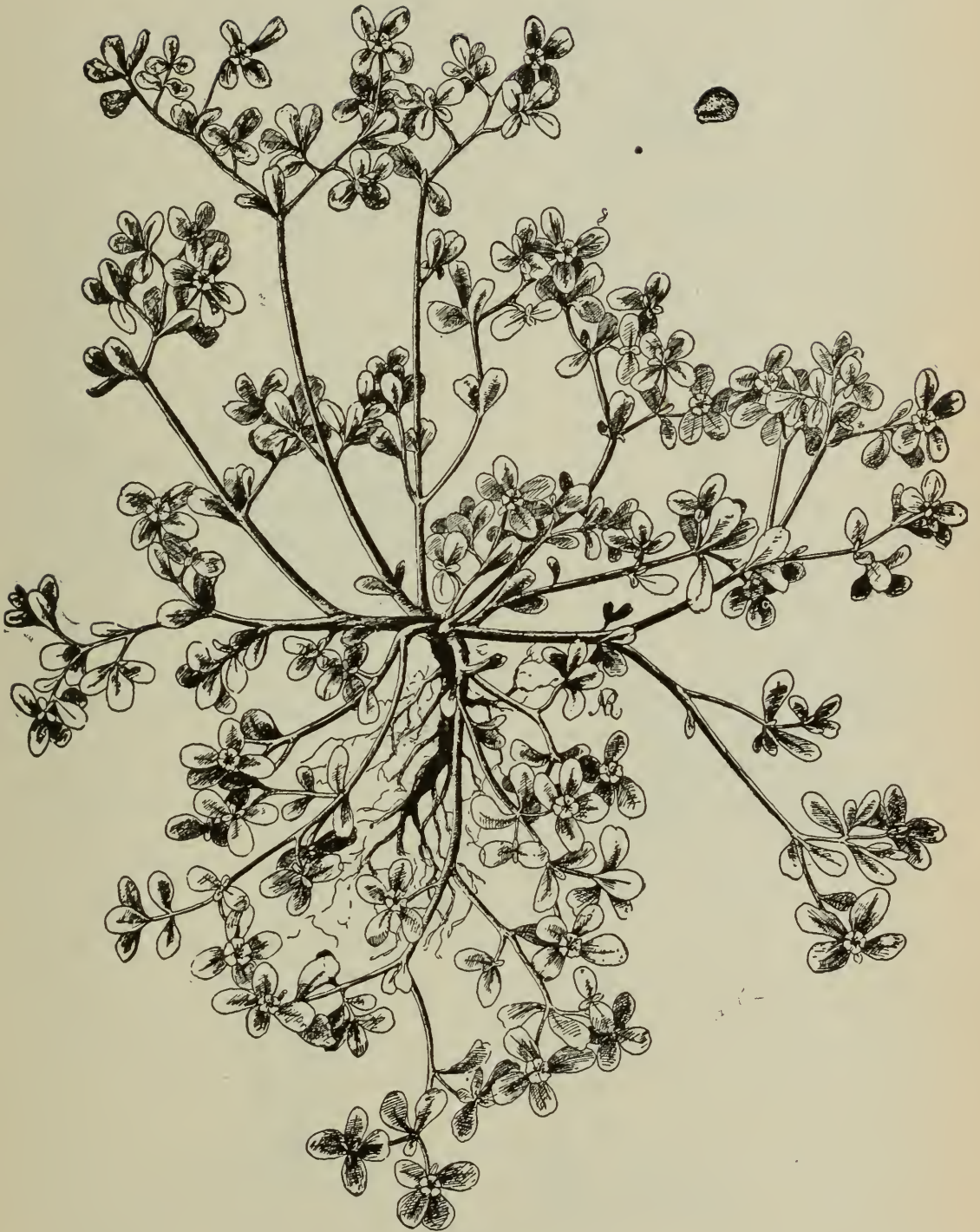


Fig. 16 Purslane (*Portulaca oleracea*).

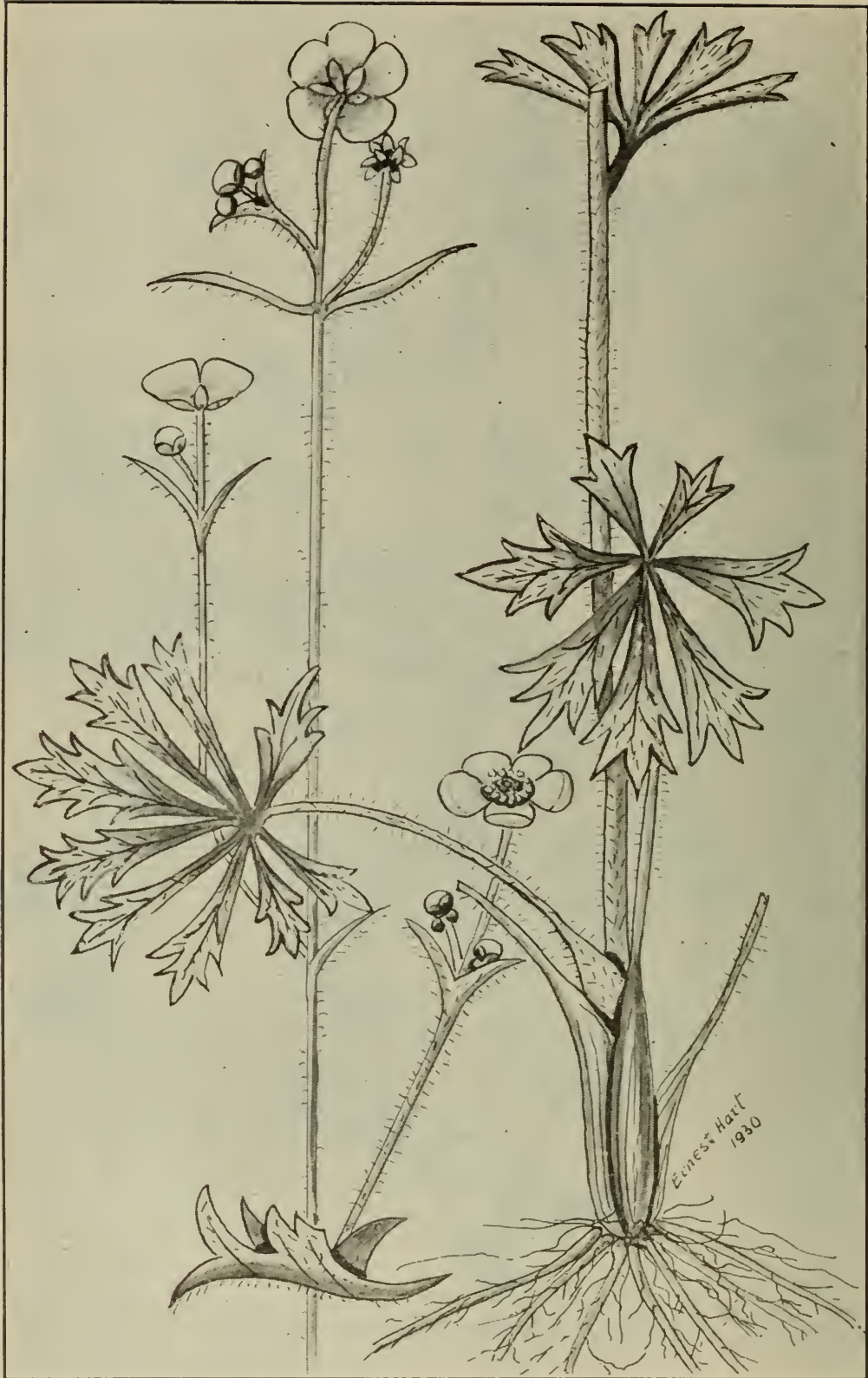


Fig. 17. Tall Buttercup (*Ranunculus acris*).

THE MUSTARD FAMILY (*CRUCIFERAE*)

PENNY-CRESS, BASTARD-CRESS, FRENCH WEED, WILD GARLIC, OR STINK-WEED
(*Thlaspi arvense*, L.) (Fig. 18.)

A winter annual, introduced from Europe, and a very bad weed. It is very abundant in Manitoba, and is becoming rather common in Ontario. It grows as an erect plant, with a number of branches from the upper part. The leaves are numerous during the first of the season, and clasp the stem by ear-like lobes. The flowers are white and small, with spreading flower stalks. The pods which succeed the flower are very characteristic. They are nearly orbicular, about half an inch broad, quite flat, with a broad wing all around, and notched at the top. Fig. 18 shows this peculiarity. Each pod produces about twelve seeds, which are dark brown to black and oval in shape, with curved lines. An average plant produces about 20,000 seeds.

The plant has a peculiar odour, resembling that of garlic, hence some of the common names. The seed has a very pungent taste. When eaten by milch cows it imparts a disagreeable flavour to the milk.

Time of flowering, May-September.

Time of seeding, June-September.

Dispersal—Chiefly by the wind.

Control. Hand pull and burn when in small quantities. If the field is badly infested the following method of eradication is recommended: *"Run a disk or harrow over the stubble as soon as the crop is removed so as to start into growth the seeds near the surface. The following spring cultivate or harrow these plants down; and as soon as a growth of fresh plants starts plow the land and harrow at once. This land may be sown late to a green feed crop or it may be kept under a clean fallow for the whole season if the land can be spared. The following spring any growth of weeds should be cultivated down before sowing the crop."

Plants with fully formed pods should never be plowed down, as the seeds will mature below the ground and maintain their vitality for considerable time.

PEPPER GRASS, OR TONGUE GRASS (*Lepidium apetalum*, Willd.) (Fig. 19.)

A native annual which grows from 6 inches to a foot and a half high. The stem usually has many branches, and the lower leaves terminate in a large lobe (with small lateral ones), with edges slightly cut in along the margin. The upper leaves are tapering. The flowers are small and white, with slender spreading flower stalks. The seed pods are round, with a very small wing at the top and a notch at the extremity. The end of a branch with seed pods is shown nearly natural size in Fig. 19.

The seeds are reddish-brown, flat and oval in shape, and $\frac{1}{12}$ inch long. The average plant produces about 18,000 seeds.

Time of flowering, June-August.

Time of seeding, July-September.

Dispersal—By birds and as an impurity in clover seeds.

Control. Be careful to prevent the plants from seeding, and do not plow them under half ripe, as many of the seeds will germinate even though partially matured. Pull and burn where only a few plants exist, and when they are numerous use the method employed for the eradication of Mustard.

*Farm Weeds of Canada.



Fig. 18. Penny-cress (*Thlaspi arvense*).

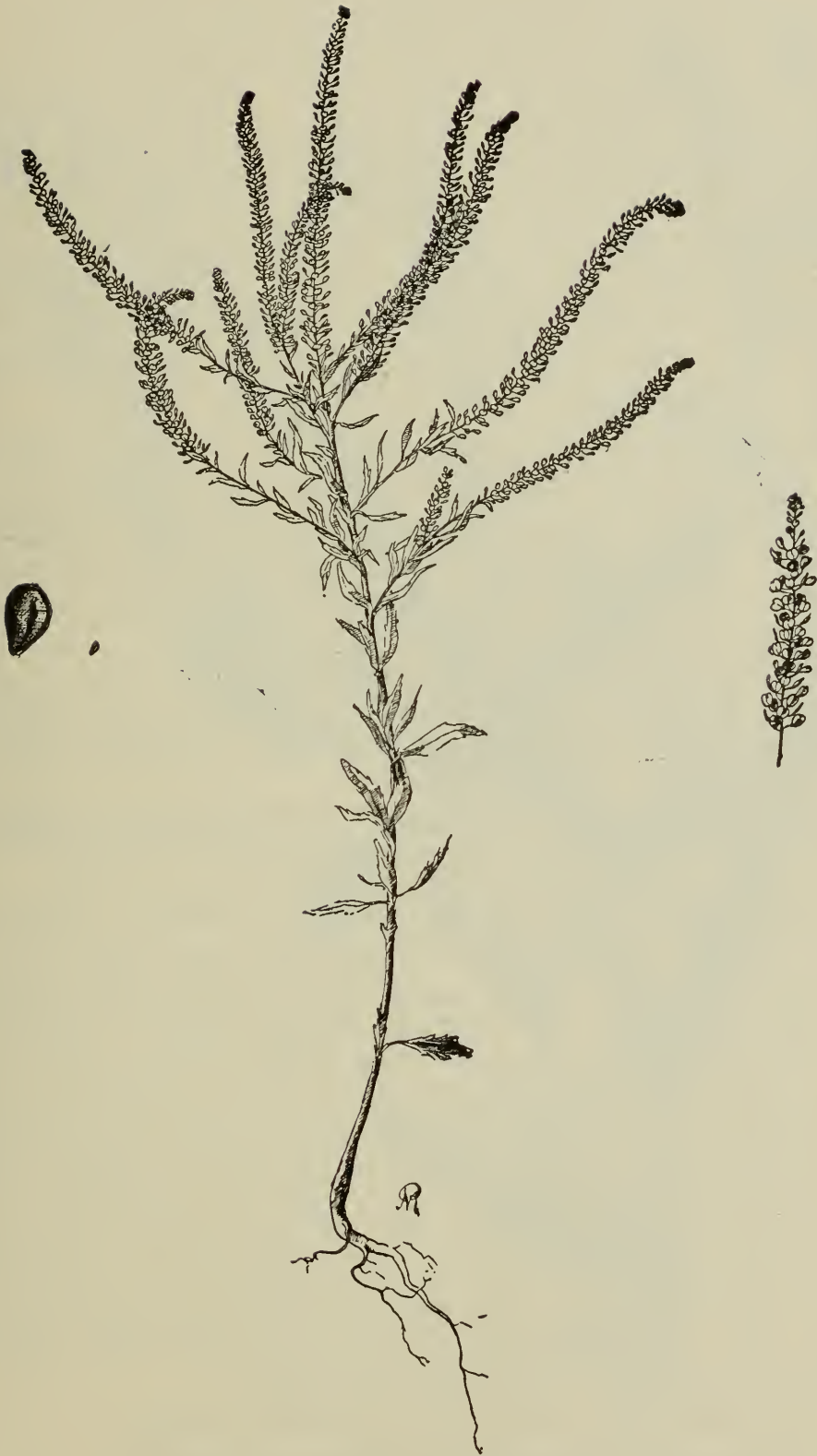


Fig. 19. Pepper Grass (*Lepidium apetalum*).

FIELD PEPPER GRASS, OR COW CRESS (*Lepidium campestre*, (L.) R. Br.)
(Fig. 20.A.)

This weed has been widely distributed throughout the Province as an impurity in clover seed. During the past twenty years it has been observed for the first time in many new districts and has caused considerable trouble in clover fields.

Field Pepper Grass or Cow Cress is an introduced annual or biennial weed. It grows from 1 to 2 feet high, and branches freely. The basal leaves are petioled, oblong and entire; stem leaves spear-shaped, entire or slightly toothed, and clasping the stem by their arrow-shaped bases. Flowers are small, white or yellowish in colour. The seed pods are broadly ovate, boat-shaped, being rounded below and hollowed out above. They stand out stiffly from the stem on pedicels of about their own length. The seeds are reddish-brown in colour, about $\frac{1}{12}$ of an inch long, sharply egg-shaped, rounded or somewhat flattened, and the surface is granular and slightly scurfy.

Control. Hand pull small patches. Cut clover early enough to prevent seeding. Plow up badly infested fields and put in a hoed crop for one season.

HOARY PEPPER GRASS (*Lepidium draba* L.) (Fig. 20.B.)

This is a perennial weed with creeping root-stocks which has been reported as appearing for the first time in various parts of the Province during the past few years. It is apparently a persistent weed, capable of spreading rapidly. A careful watch should be kept for it so that stray plants and small patches may be destroyed and thus the pest prevented from becoming established on the farm.

Hoary Pepper Grass has oblong or oval obscurely hoary leaves and the upper clasping the stem, and small white flowers in more or less flat topped clusters. These are succeeded by small, thick, heart-shaped pods with a conspicuous point (style) on the end. (See Fig. 20B).

Control. Small patches can be destroyed by hand pulling or digging out the plants before they go to seed, or by spraying with a chemical weed killer.

SHEPHERD'S PURSE (*Capsella bursa-pastoris* (L.) Medic) (Fig. 21.)

A winter annual, naturalized from Europe, with a long, deep, tap root. The root leaves are lobed and form a large rosette, which lies close to the ground, and in this state it passes the winter. The following spring a more or less branched stem arises, with arrow-shaped leaves thereon. The flowers are very small and white in colour, and are much less conspicuous than the seed vessels, which are triangular in shape, and are attached to the stalk or pedicel at the lower apex of the triangle. From the character of these pods the plant obtains its scientific and common name. The triangular pod is divided down the centre by a partition, forming two cells, each of which contains from 10 to 12 seeds (Fig. 21). In size the plant varies greatly from a few inches to 2 feet, depending on the soil and locality. But even a very diminutive plant produces many seeds. The seed is very small, light brown in colour, and oblong in shape (Fig. 21). An average plant produces over 50,000 seeds. Fig. 21 shows shape of seed, also the arrangement of seeds in the pod.

Time of flowering, early spring till the beginning of winter.

Time of seeding, early spring till the beginning of winter.

Dispersal—As an impurity in grass seed; also by birds, as the pods when ripe open and drop the seeds, which are eaten by birds, and often evacuated without digestion or injury.

Control. It easily succumbs to cultivation; and as the plant spreads only by seed, persistent effort should be made to prevent seeding.



Fig. 20A. Field Pepper Grass or Cow Cress (*Lepidium campestre*).

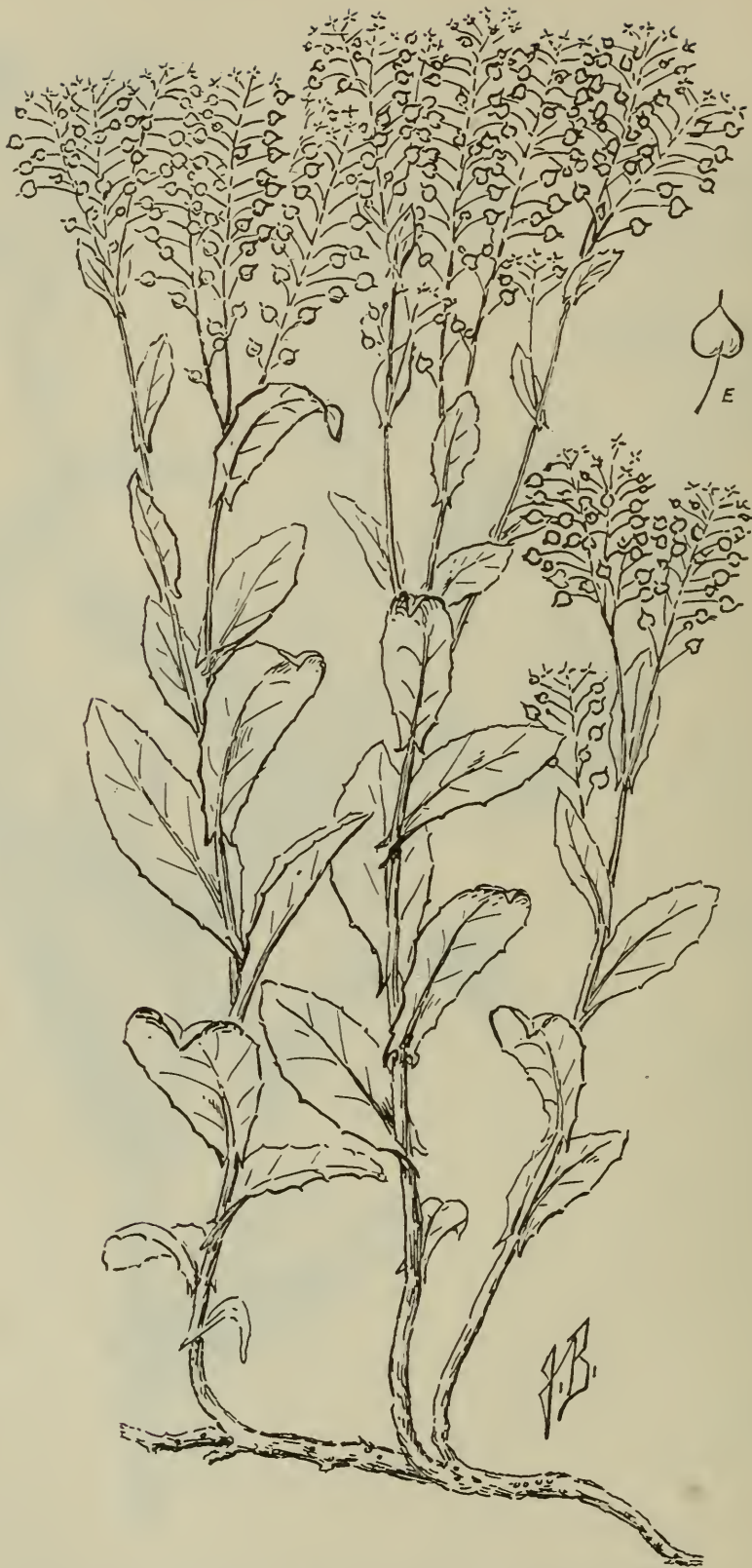


Fig. 20.B. Hoary Peppergrass (*Lepidium draba*).

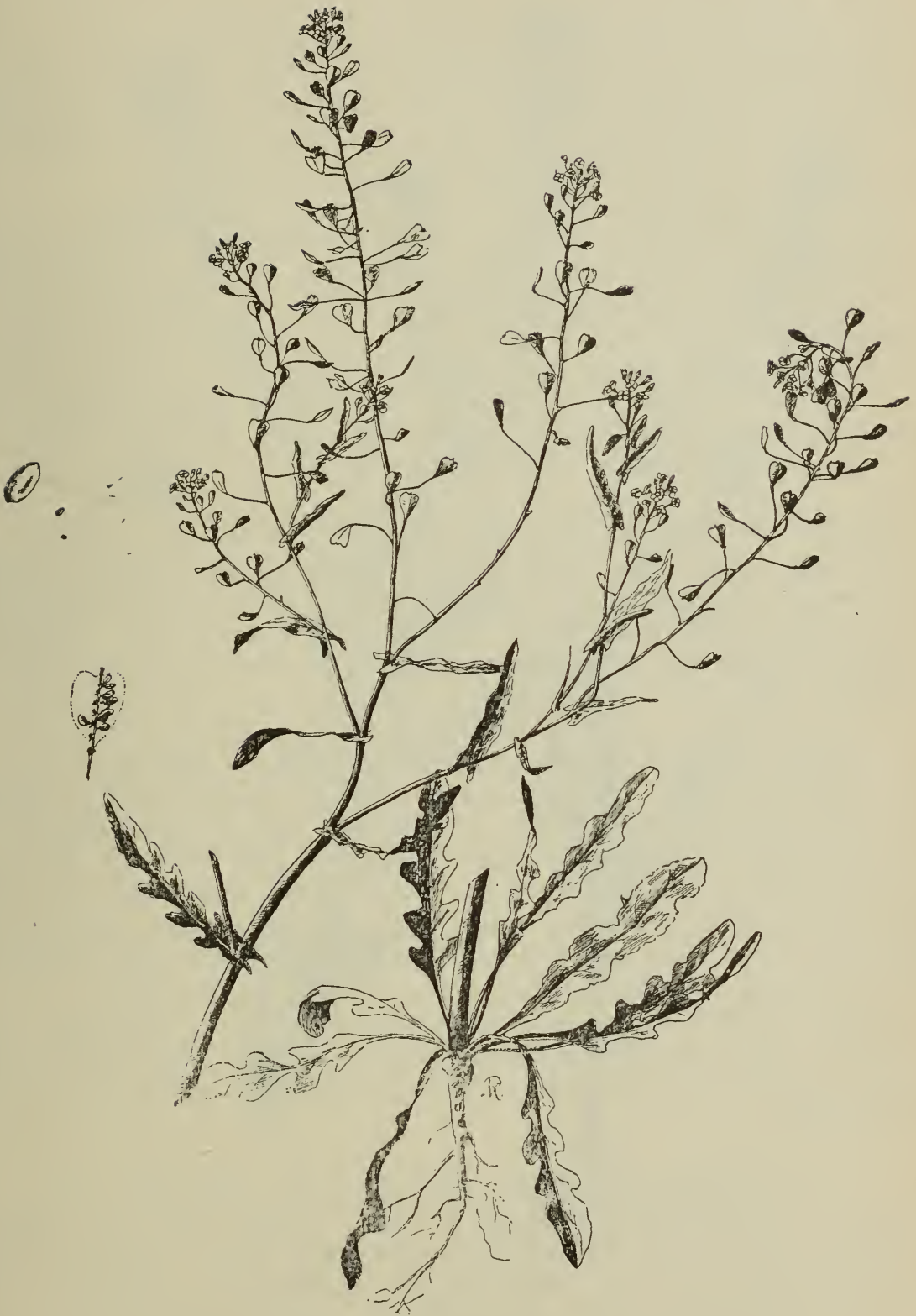


Fig. 21. Shepherd's Purse (*Capsella bursa-pastoris*).

SMALL SEEDED FALSE FLAX (*Camelina microcarpa* Andr.) (Fig. 22.)

This is an introduced annual and winter annual, very frequently seen in fall wheat and alsike clover. The stem is simple or branching; the lower leaves are long with a stem or petiole, and the upper ones clasp the stem with arrow-shaped bases. The flowers are numerous, pale yellow, and somewhat inconspicuous. The seed vessel or pod is somewhat pear-shaped with a small projection from the upper end. The little stalks holding the seed pods are slender and spreading or ascending. The seed is reddish brown with minute whitish spot at the small end, somewhat oval in shape, about 1/20 of an inch in length, the surface very finely granular roughened and grooved lengthwise. An average plant produces about 40,000 seeds.

Time of flowering, June-August. Time of seeding, July-October.

Dispersal—As an impurity in clover and grass seeds, especially alsike and timothy.

Control. This weed does not long give serious trouble where a short rotation of crops is practised and where thorough cultivation and seeding to grasses is done with spring grains instead of fall wheat. If the field is very badly overrun with this weed proceed as follows: Plow lightly as soon as the crop is harvested; harrow and then cultivate frequently throughout the autumn to destroy the young seedlings. It is important that this autumn cultivation should be thorough. Put a hoed crop in the field the following year and give it good cultivation.

COMMON OR WESTERN FALSE FLAX (*Camelina sativa* (L.) Crantz)

This is the common false flax of Western Canada. It was probably introduced into this country as an impurity in imported flax seed. In Europe it is cultivated for the fine oil extracted from the seed, which is used in feeding cattle. It resembles the small seeded false flax, but is coarser and has larger flowers, pods and seeds.

Control. The same as for the preceding species.

BALL MUSTARD (*Neslia paniculata*, (L.) Desv.) (Fig. 23.)

A weed of European origin, common in grain fields in the Western Provinces and now becoming frequent along railway lines and in waste places in Ontario.

A slender annual or winter annual from 2 to 3 feet high. Leaves oblong, pointed and clasping the stem at the base. Flowers small, orange yellow in colour, in long, slender terminal clusters (racemes). Pods round, veiny ridged and containing a single yellow seed. They do not split open, and are commonly taken for the seeds. They are frequently found in seed grain and screenings from the West.

Control. Avoid sowing seed grain containing "seeds" of this weed. Hand pull and burn when in small quantities. Badly infested fields should be given thorough early after-harvest cultivation, followed by spring cultivation and a hoed crop next season.

WILD RADISH (*Raphanus raphanistrum*, L.) (Fig. 24.)

This is a weed of European origin which is a serious pest in the Maritime Provinces, and which has recently been introduced into Ontario. It is an annual and winter annual from 1 to 2 feet high. In general appearance it is like the Wild Mustard, but its yellow flowers have purplish veins in the petals and the pods are much more jointed in appearance. The seeds are 1/10 of an inch long, light reddish-brown, oval in outline, and with the surface finely roughened.

Time of flowering, June to September; seeds ripen by August.

Dispersal—By seeds.

Control. Hand pull when it first appears to prevent it from spreading. If it becomes very plentiful, follow the method of cropping outlined for Wild Mustard.

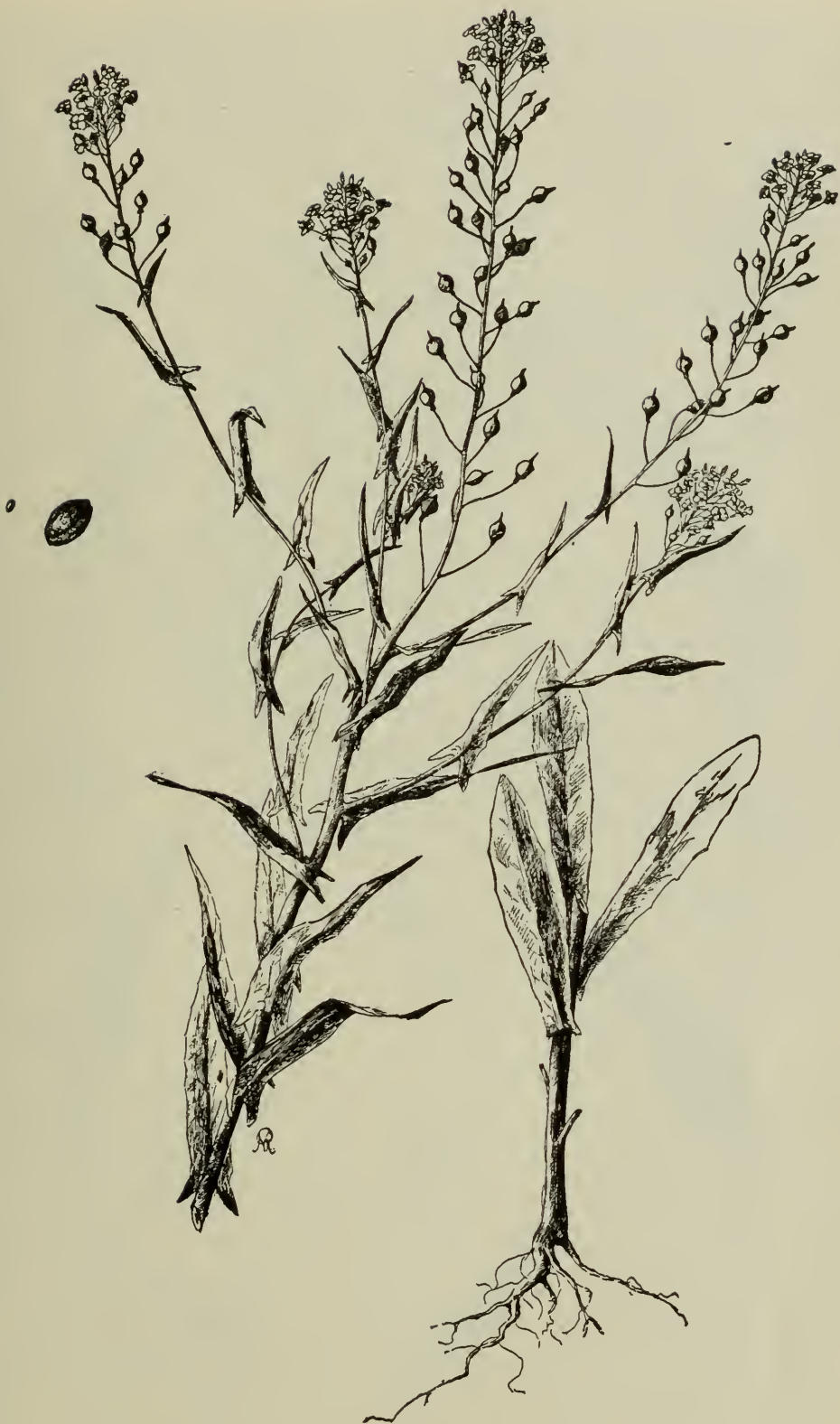


Fig. 22. Small Seeded False Flax (*Camelina microcarpa*).

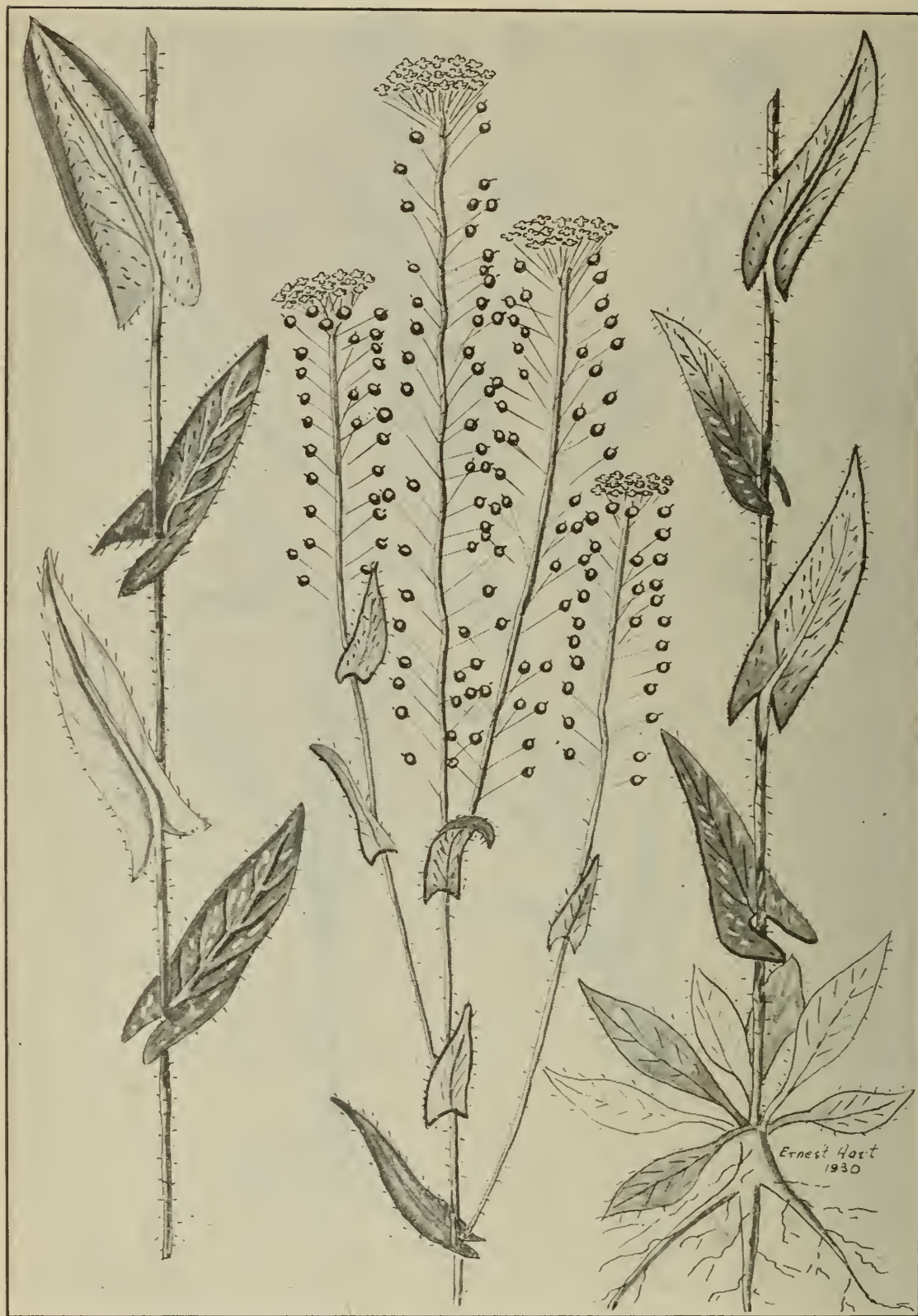


Fig. 23. Ball Mustard (*Neslia paniculata*).



Fig. 24. Wild Radish (*Raphanus raphanistrum*).

WILD MUSTARD, CHARLOCK, OR HERRICK (*Brassica arvensis* (L.), Ktze.)
(Fig. 25.)

Among the worst weeds in Ontario is the Wild Mustard, an annual, naturalized from Europe, with fibrous roots and erect habit of growth. The stem is rough with stiff hairs somewhat scattered over the surface. The branches arise from the upper part of the stem and bear oblong leaves and the lower leaves have one terminal large lobe and several smaller lateral ones (lyre shaped). The flowers are yellow, showy, and about $\frac{1}{3}$ of an inch broad, with stout flower stalks, which are more noticeable when the plant is in fruit. The pods, which appear on the lower part of the stem whilst the top is in flower, are from 1 to 2 inches long, and are either spreading or ascending.

The shape of the pod is characteristic; it is constricted between the seeds, thus giving the appearance of a rounded enlargement where each seed is borne. This appearance is termed "knotted." The pod terminates in a two-edged beak, and the two valves of the pod are strongly veined or ribbed.

The seed (see Fig. 25) is black, $\frac{1}{16}$ inch in diameter, perfectly spherical, and very much like rape or turnip seed, and it retains its vitality for a long time when buried in the soil. An average plant produces 15,000 seeds.

Time of flowering, June-September.

Time of seeding, July-September.

Dispersal—By birds and implements, but chiefly as an impurity in seed.

Control. Owing to the great vitality of the seed, Mustard is a very hard weed to eradicate. The seeds, once in the ground, live for years, and continue to germinate as they are brought near the surface. Hence it takes patience, a great deal of labour, and a long time to get rid of the weed when it once gets possession of the land. When present only in small amounts, hand-pulling is the best method, providing the pulling is done before seeds have formed; and as persons pulling in a hurry cannot wait to examine for seed, it is best to put the weeds, as they are pulled, in bundles where they can be burned when dry.

When fields are overrun with the weed, it is best to proceed as follows: Harrow stubble-ground early after harvest, or gang-plow and harrow. As soon as the seeds have had time to sprout, cultivate thoroughly; repeat cultivation at intervals; and rib up with a double mould-board plow the last thing in the fall. Put in a hoed crop, either roots or corn, the following spring, and cultivate it thoroughly throughout the growing season. Cultivate and harrow well two or three times after roots or corn, having first run the plow along each row of corn roots to cut the roots and turn them up; and rib up before the frost. (If the plow is used after roots or corn, it is likely to bring more seed to the surface.) Sow a crop of grain the following spring and seed with clover. Pull weeds by hand out of the grain crop; take a crop or two of hay, or pasture; and break up the clover sod, treating it as outlined on page 5. When necessary at any stage in this method, use a grubber or subsoil plow to stir the soil to a greater depth than is reached by the surface cultivation.

SPRAYING WITH IRON SULPHATE TO DESTROY MUSTARD IN CEREAL CROPS

Iron sulphate or copperas can be successfully used to destroy Mustard in standing grain without injury to the crop.

Preparation of Solution. A 20 per cent. solution should be applied. This can be prepared by dissolving eighty pounds of iron sulphate in forty gallons of water.



Fig. 25. Mustard (*Brassica arvensis*).

Iron sulphate is dissolved quite readily in cold water. The solution should be strained through a cheese cloth, as it is put into the spray pump tank. This will remove dirt and small particles that are apt to clog the nozzles.

Time to Apply. Apply on a calm, clear day, just as soon as the first few plants in the fields show flowers. *It is very important to spray early.* If the plants are left too long the treatment is not nearly so effective. If a heavy rain comes within twenty-four hours after the solution is applied, it will be necessary to spray again.

How to Apply the Solution. An ordinary hand pump barrel sprayer, such as is employed to spray fruit trees, may be used, or a potato sprayer can be rigged up to do the work. Many of the up-to-date sprayers have a special broadcast attachment for spraying weeds. These are excellent for large areas, as they cover a wide strip at each round. Care must be taken to see that every Mustard plant is covered with the solution in the form of a fine spray.

Iron sulphate may be obtained at any hardware store or from the wholesale chemical companies in Toronto. In wholesale lots it is better purchased from such companies; they can supply it much cheaper in large quantities than it can be purchased at local hardware stores.

See also directions for spraying with copper sulphate, page 117.

HARE'S-EAR MUSTARD (*Conringia orientalis*, (L.) Dumort) (Fig. 26.)

A weed which is quite general throughout the West, in grain fields, on stubble and by roadsides; spreading rapidly. It has been found in one or two places in Ontario. An annual and winter annual with a straight, slightly branched stem from 1 to 3 feet high. Whole plant smooth and when young covered with a bloom like that of a cabbage. Leaves somewhat fleshy, oblong, oval, entire, and clasping the stem by two rounded lobes. They resemble in shape a hare's or rabbit's ear, hence the common name, Hare's-ear Mustard. Flowers are creamy white, about $\frac{1}{4}$ inch across. Pods are four-sided and 3 to 4 inches long. Seeds are dark reddish brown, $\frac{1}{12}$ of an inch long, somewhat wheat-shaped, with the surface granular roughened.

Time of flowering, July; seeds ripen in August and September.

Dispersal—By seeds.

Control. Hand pull small patches when the weed first makes its appearance. If a field becomes badly infested, try thorough, early, after-harvest cultivation.

TUMBLING MUSTARD (*Sisymbrium altissimum*, L.)

This mustard, which is troublesome in the West, is now found in many parts of Ontario, though it has not yet become a pest in cultivated fields in this Province. The fact, however, that it produces great quantities of seed indicates that if neglected it may become a serious nuisance. It is therefore advisable that a watch be kept for it in order that any plants which appear in cultivated fields may be destroyed before they mature their seeds.

Tumbling Mustard is a bushy-branched annual or winter annual, from 2 to 5 feet high. The lower leaves are pinnatifid with the segments pointing backward (runcinate); the upper leaves are very variable in size and outline, but are all deeply pinnatifid with narrow segments. The flowers are numerous at the end of the branches, pale yellow, and about $\frac{1}{3}$ of an inch in diameter. They are succeeded by long, slender pods, each of which contains numerous seeds. The plants, when mature, break off near the surface of the ground and are rolled about by the wind, scattering their seeds as they go. It is from this tumbling habit that the plant gets its name, Tumbling Mustard. The seeds are very small, less than $\frac{1}{24}$ of an inch in length. They are greenish yellow to olive brown in colour and somewhat



Fig. 26. Hare's ear Mustard (*Conringia orientalis*).

U-shaped. Being so very small they are not readily crushed by grinding, and thus frequently find their way unharmed into chop. It has been estimated that a single plant may produce a million and a half seeds, but fortunately they do not appear to have the vitality of the seeds of Field Mustard.

Time of flowering, June to September; seed ripe in August.

Dispersal—By seeds.

Control. Pull stray plants along the roadsides and in waste places before they mature. Hand pull in fields unless very abundant. Badly infested fields may be cleaned by fall cultivation and harrowing over spring grain to destroy the seedlings.

GREEN TANSY MUSTARD (*Sisymbrium incisum*, Engelm., var. *filipes*, Gray)
(Fig. 27.)

A common weed in grain fields in the West. In Ontario it is found chiefly along railways and in waste places. During the year 1910 it was reported as growing as a weed in cultivated fields from one county in Ontario. It is a biennial weed and produces the first season a rosette of finely divided leaves which lie on the ground; the second season it produces a much branched stem from 2 to 4 feet high. Leaves bright green, much divided into fine segments. Flowers bright yellow, $\frac{1}{8}$ of an inch across, borne in elongated clusters (racemes) and succeeded by narrow, smooth, slightly curved pods from $\frac{1}{2}$ to $\frac{3}{4}$ inch long, on slender, spreading stems. Seed is brownish red, about $\frac{1}{25}$ of an inch long, somewhat oblong in shape.

Time of flowering, July; seeds ripe in August.

Dispersal—By seeds.

Control. Hand pull. Thorough fall and spring cultivation will clean badly infested fields.

WORMSEED MUSTARD, OR TREACLE MUSTARD (*Erysimum cheiranthoides*, L.)
(Fig. 28. A.)

A native weed, which seems to be spreading rapidly through the Province. Many specimens have been sent here for examination during the past years.

An annual or winter annual with erect and branching stems from 8 inches to 2 feet high. The foliage is bright green and abundant. The leaves are long, tapering at the base into a short petiole, and they are covered with T-shaped hairs. The flowers are yellow and about $\frac{1}{4}$ inch across. The little stalks (pedicels) holding the pods, come out from the stem obliquely, but the pod stands erect on the pedicel, parallel with the stem. The pod is about an inch long and four-angled, with one row of seeds in each cell. The seeds are $\frac{1}{16}$ inch long and light brown in colour, with a furrow on one side. An average plant produces 25,000 seeds.

Seeds give a bitter taste to feed containing them.

Time of flowering, June-July.

Time of seeding, July-October.

Dispersal—Frequently as an impurity in clover seed.

Control. Hand pulling and burning is the best remedy when the weed occurs in small quantities; but where there is much of it, the following procedure is advised: Harrow stubble-ground early after harvest, or gang-plow and harrow. As soon as the seeds have had time to sprout, cultivate; repeat cultivation, and rib up the land with a double mould-board plow the last thing in the fall. Put in a hoed crop, either

roots or corn, the following spring, and cultivate thoroughly throughout the growing season. Cultivate after the roots or corn, sow a crop of grain, and seed with clover. If not too much, pull weeds by hand out of the growing crop.



Fig. 27. Green Tansy Mustard (*Sisymbrium incisum*).



Fig. 28A. Worm-seed Mustard (*Erysimum cheiranthoides*).

YELLOW ROCKET (*Barbarea vulgaris*, L.) (Fig. 28.B.)

This is a weed which is often seen in the early summer, especially in the low, damp parts of the fields. It causes considerable alarm, as it is often mistaken for Mustard or Charlock. It belongs to the mustard family but if observed at all closely, it is easily seen to be very different from Mustard or Charlock which it resembles only in the colour of the flower. It is not nearly so rough and coarse a plant. The leaves are smooth and shiny, and dark green in colour, somewhat oval in shape. The lower are petioled and much divided, the terminal division being much larger than the basal ones. The upper leaves are sessile and slightly clasping. The seeds are



Fig. 28.B. Yellow Rocket or Cress (*Barbarea vulgaris*).

light brown in colour with a dull and roughened surface. They are more or less oblong in form and somewhat flattened.

This is a perennial plant, and while it often occurs quite plentifully in low spots in the field, it has never given serious trouble as a weed, as it does not seem to survive good cultivation when the land is well drained.

THE ROSE FAMILY (*ROSACEAE*)

ROUGH CINQUEFOIL (*Potentilla monspeliensis*, L.) (Fig. 29.)

A native annual weed found frequently in meadows and hay fields in some parts of Ontario. Stem erect, branching, rough-hairy. Leaves compound, with three somewhat oblong, oval, toothed leaflets. Flowers bright yellow, in terminal clusters (cymes). The seeds are light brown, about $1/30$ of an inch long, blunt and slightly curved, with branching longitudinal veins on the surface.

Time of flowering, June to July; seeds ripe July to September.

Dispersal—By seeds, which are frequently found in timothy seed.

Control. This weed will not persist in cultivated crops. Repeated close cutting in hay fields, meadows and waste places will destroy it.

UPRIGHT OR ROUGH-FRUITED CINQUEFOIL (*Potentilla recta*, L.)

A perennial weed with larger, paler, yellow flowers than the last, and 5 to 7 leaflets in each leaf. It is reported as being troublesome in meadows and hay fields in some parts of Ontario. Breaking up the field and putting it under a cultivated crop should clean out this weed.

THE PEA FAMILY (*LEGUMINOSAE*)

PURPLE TUFTED VETCH, OR PERENNIAL VETCH (*Vicia cracca*, L.) (Fig. 30.)

This is a persistent perennial weed which sometimes overruns old meadows. It, however, produces fodder of high food value, and is, therefore, often considered beneficial rather than detrimental in meadows. The plants are finely hairy, rarely smooth. The stems are tufted, weak, climbing or trailing, often 2 to 4 feet long. The flowers are bluish purple in dense spike-like clusters of twenty or more. The leaves are compound with ten or twelve pairs of leaflets. The seed is spherical, varying from $1/10$ to $1/8$ of an inch in diameter, velvety black or olive brown, mottled with white and black spots, and with a broad whitish scar about one-third or one-half the circumference.

Control. The methods which are used in controlling Canada Thistle and Perennial Sow Thistle are effective with this weed.

WILD TARE, WILD PEA, OR WILD VETCH (*Vicia angustifolia* (L.), Reich.)

This is an annual plant somewhat similar to Purple Tufted Vetch, but the flowers instead of being in dense clusters are borne singly or in pairs in the axils of the leaves. The seeds are very similar to those of the Purple Tufted Vetch, but can be distinguished from them by the narrower thread-like scar about one-fifth the circumference. They are very frequently found in grain. The plants are sometimes numerous and mat a crop by twining around the stems of the grain.

Control. Sow only clean seed grain. Gang plow and harrow stubble ground early after harvest and pasture off or cultivate out the crop of tares that develops.

BLACK MEDICK, OR YELLOW TREFOIL (*Medicago lupulina*, L.) (Fig. 31)

This is an annual weed of secondary importance which is often found in meadows, hayfields, and in lawns. It has considerable food value, and in Europe the seed is frequently sown with grass seed mixtures. It is often a nuisance in red

clover and alsike fields. The seed is a frequent impurity in alsike and red clover seed. The plants are low and spreading with trifoliate leaves somewhat similar to those of clover. The flowers are small, yellow in colour and clustered in little dense heads borne on stalks in the axils of the leaves. The pods are black, curved and conspicuously veiny ridged. Each one contains a single yellow seed with a minute nose-like projection on one side.

Control. This plant does not persist when a field is plowed and brought under cultivation and therefore is seldom troublesome when a short rotation of crops is followed.



Fig. 29. Rough Cinquefoil (*Potentilla monspeliensis*).

ST. JOHN'S-WORT FAMILY (*HYPERICACEAE*)COMMON ST. JOHN'S WORT (*Hypericum perforatum*, L.) (Fig. 32.)

This weed is sometimes troublesome in permanent pastures and meadows. It does not persist where a systematic short rotation of crops is practised.

Common St. John's-Wort is a perennial weed with slender creeping "roots," stems clustered, woody at the base, upright, from 1 to 2 feet high; leaves without stems (sessile), opposite, entire, elliptic or linear oblong in outline, black dotted on the edges, and with semi-transparent dots all over, which can be readily seen when



Fig. 30. Purple Tufted Vetch or Perennial Vetch (*Vicia cracca*).

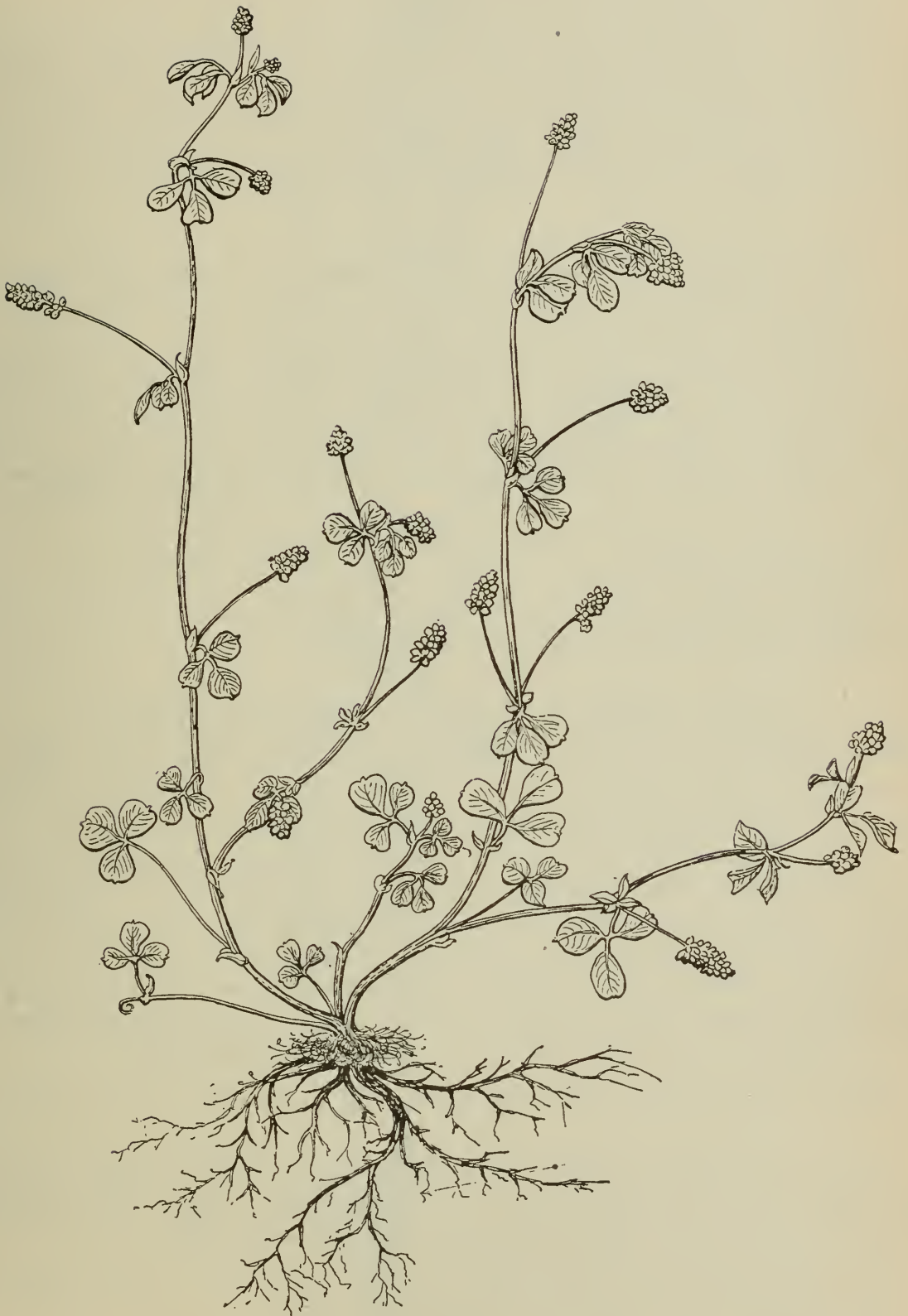


Fig. 31. Black Medick or Yellow Trefoil (*Medicago lupulina*).

the leaves are held up to the light; flowers borne in loose terminal clusters, the petals with black dots on the margin. The seeds are about $1/24$ inch long, cylindrical, rounded at the ends, dark brown to black in colour.

Time of flowering, from June to September.

Time of seeding, from July to October.

Control. In meadows or pastures which cannot be brought under cultivation, close cutting several times during the summer is recommended. An application of salt, a small handful, to each plant after close cutting in hot dry weather is also recommended where the weed is not too abundant. If the land can be cultivated and brought under a systematic rotation of crops, the St. John's-Wort will soon be suppressed.

THE EVENING PRIMROSE FAMILY (*ONAGRACEAE*)

COMMON EVENING PRIMROSE (*Oenothera biennis*, L.) (Fig. 33.)

A tall, stout, native biennial weed found frequently in Ontario in hayfields and on the edges of cultivated fields. The leaves are from 1 to 6 inches long, oblong to lance-shaped, with wavy, slightly toothed margins. Flowers open in the evening and are large and bright yellow in colour. Seed pods lie close to the stem and are about an inch in length. Seeds are reddish brown and irregular in outline, 4 to 5 sided.

Time of flowering, June to September; seeds ripe by August.

Dispersal—By seeds.

Control. Spud out plants on the headlands and in the fence corners. Never troublesome when a field is brought under cultivation.

THE PARSLEY FAMILY (*UMBELLIFERAE*)

SPOTTED COWBANE, OR WATER HEMLOCK (*Cicuta maculata*, L.) (Fig. 34.)

A weed of wet, marshy places. Cattle are frequently poisoned by eating the roots of this plant, especially early in the spring when pasture is scarce.

A smooth perennial from 2 to 5 feet high. Leaves compound, of 2 or 3 divisions, the stalks, with expanding bases which clasp the stem, the leaflets lance-shaped and sharp-toothed. The flowers are small, white and in flat topped clusters (umbels). The root consists of a number of spindle-shaped "tubers."

Control. Watch marshes and low places for this weed and hand pull any plants that are found. This is easily done if the roots are first loosened with a spud or other implement. Be sure to destroy the plants after pulling them.

WILD CARROT, BIRD'S NEST, OR DEVIL'S PLAGUE (*Daucus carota*, L.) (Fig. 35.)

This is a biennial, naturalized from Europe, with a deep, strong tap root, a bristly stem, and much divided leaves like the cultivated carrot. The clusters of flowers are in compound umbels which resemble bird-nest cavities.

Time of flowering, July-September.

Time of seeding, August-December.

Dispersal—By seeds carried by wind and animals.

Control. Spudding is quite effective when the roots are cut before blossoming the first season. When the field becomes badly infested it should be plowed and cultivated and treated to a hoed crop. Sheep will suppress it in pasture lands. A chemical weed killer can be used to advantage to destroy wild carrot on roadsides and in permanent pastures. See page 115.



Fig. 32. Common St. John's-wort (*Hypericum perforatum*).

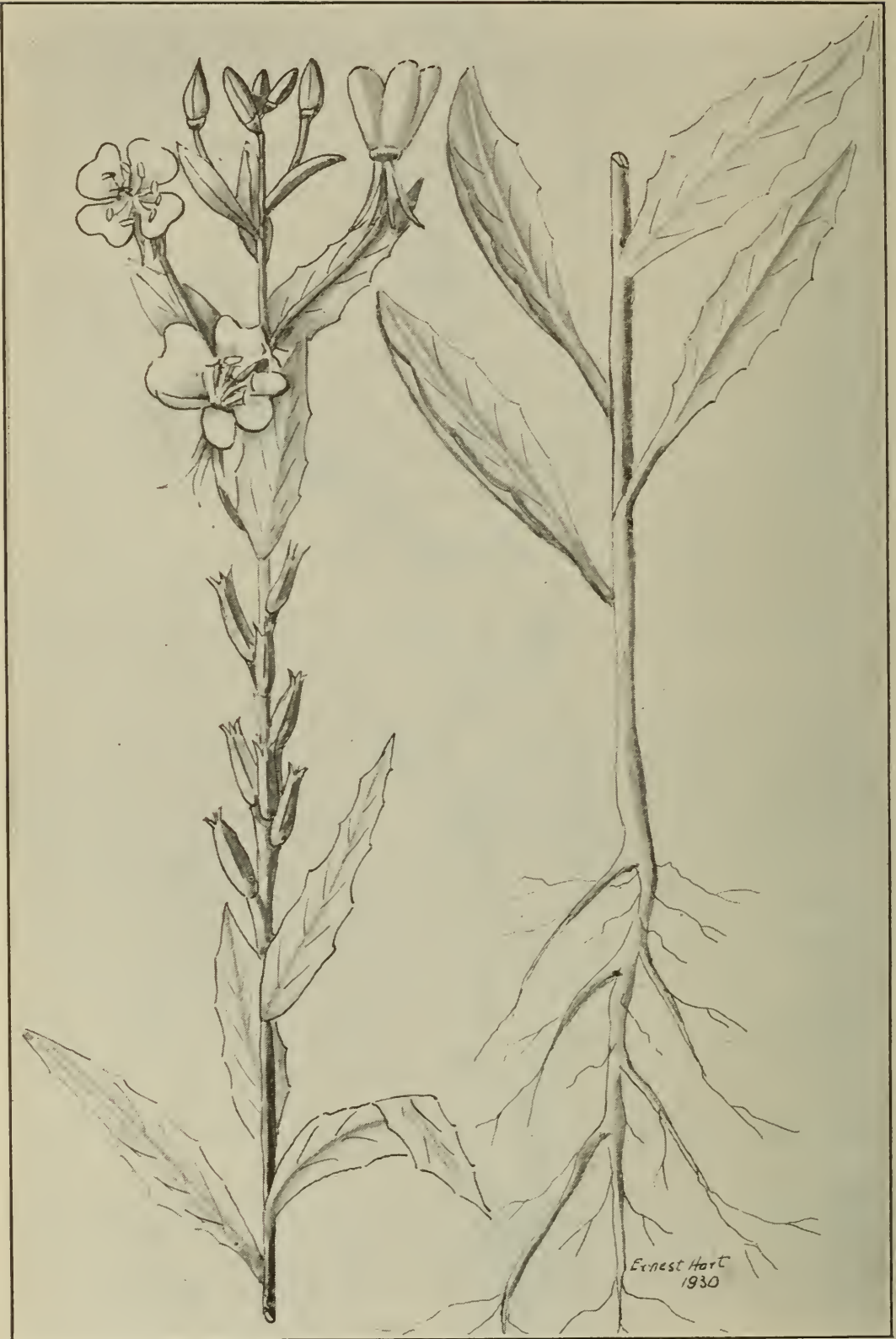


Fig. 33. Common Evening Primrose (*Oenothera biennis*).

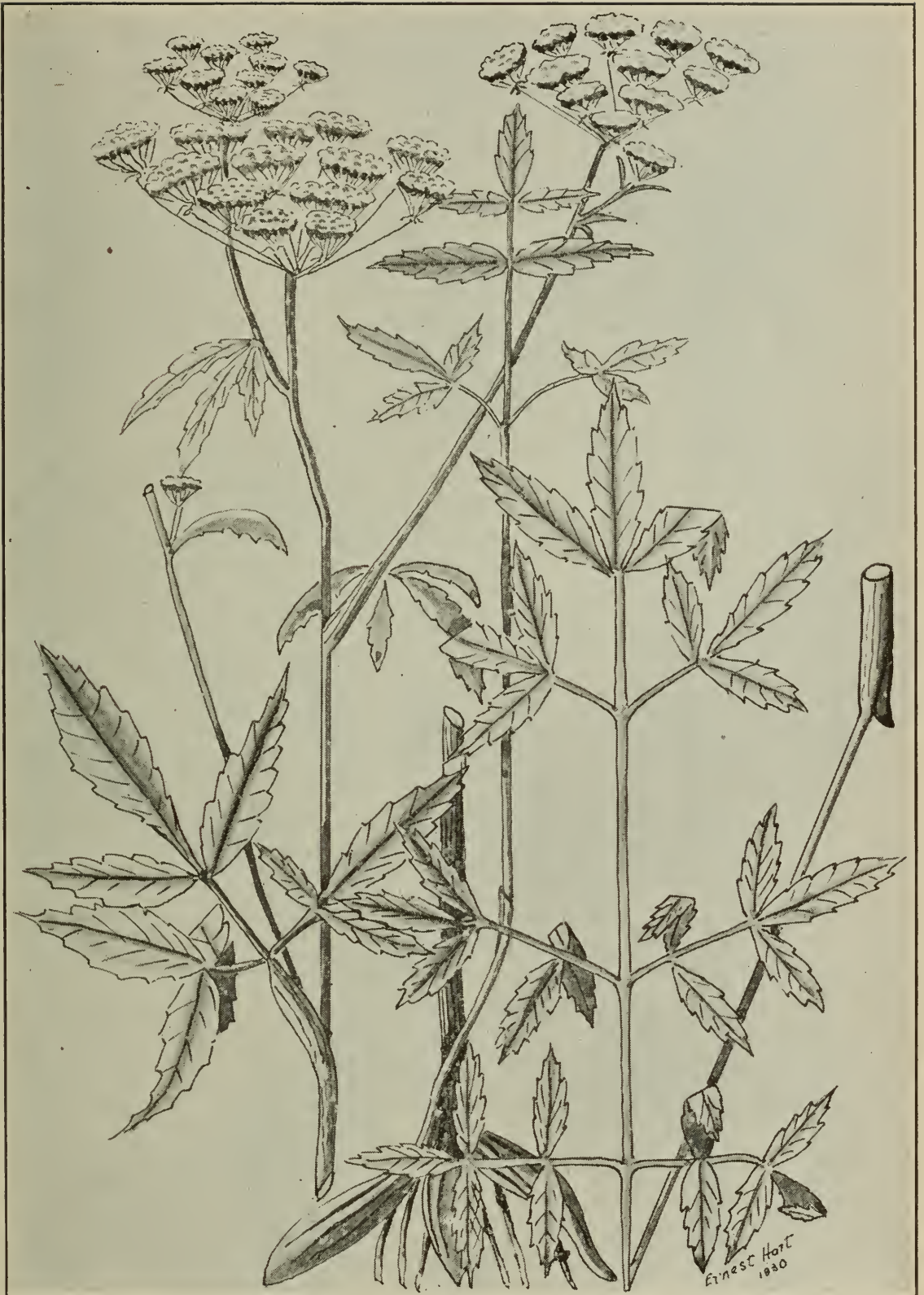


Fig. 34. Spotted Cowbane or Water Hemlock (*Cicuta maculata*).



Fig. 35. Wild Carrot (*Daucus carota*).

MILKWEED FAMILY (*ASCLEPIADACEAE*)MILKWEED, OR SILKWEED (*Asclepias syriaca*, L.)

This plant quite frequently appears in cultivated crops in Ontario, and once it becomes established its extermination is a difficult task.

It is a deep-rooted perennial weed, with a stout stalk from 2 to 5 feet high covered with soft hairs. Leaves large, lance-oblong to broadly oval with fine down on the under surface. Flowers dull purple to white in colour and borne in compact clusters (umbels). Fruit, a large pod which opens down one side (follicle) to allow the white plumed seeds to escape.

Control. Cut early to prevent from seeding. Spud out scattered plants in meadows and grain fields. If a field is very badly infested break it up and follow one of the methods suggested for Perennial Sow Thistle.

MORNING GLORY FAMILY (*CONVOLVULACEAE*)FIELD BINDWEED, OR WILD MORNING GLORY (*Convolvulus arvensis* L.)

((Fig. 36.)

A very troublesome weed which winds its tough and curling stems around the stalks of various plants, partially chokes them, and thereby hinders their growth. It is a perennial with very extensive creeping "root" which penetrates far into the soil, and any piece of the "root" possessing one or more buds is capable of starting new plants; hence it is necessary to clean implements very thoroughly after they have been used in a field containing this weed. The stems are branched and either trail on the ground or climb by twisting around some other plant. The leaves are rather small, with 2 or 4 lobes at the base, giving them an arrow-headed shape. The flowers are white or rose-coloured and 1 inch across. The seeds, three in number, are large, brown and angular, and are held in a spherical capsule (Fig. 36). An average plant produces about 160 seeds.

Time of flowering, June-September.

Time of seeding, August-October. Often no seed is produced.

Dispersal—Chiefly by means of creeping root stocks, sometimes as an impurity in seed grain and mangal seed.

Control. Get on the field just as soon as the land is dry enough to permit of cultivation. Do not give the Bindweed a chance to make any early spring growth. If the field is in sod plow shallow. If the land was plowed in the fall it will not be necessary usually to plow again in the spring. Cultivate every week or ten days with a cultivator with broad points that will cut the plants off an inch or two below the ground without bringing the creeping root-stocks to the surface. Continue cultivation until it is time to put in a hoed crop, potatoes, turnips, mangels, or if you are in a section where the corn borer is not troublesome, corn may be planted. It is best to put it in hills 42 inches apart so that it can be cultivated both ways. As soon as the hoed crop is up cultivate it at least every two weeks, oftener if possible, until it occupies all the land, and makes further cultivation impossible. Just as soon as the crop is harvested plow shallow and then cultivate every ten days or two weeks with a broad-shared cultivator. It is very important to cultivate as soon as the crop is off so that the Bindweed will not have a chance to get started into late fall growth.

Last thing in the fall rib up the land into drills, and allow to stand over winter. The frost in all probability will render material assistance in the eradication. The following spring start cultivation with the broad-shared cultivator as soon as you can get on the land. Repeat frequently enough to prevent the Bindweed making any growth above the ground, until the first or middle of June. Then sow pasture rape

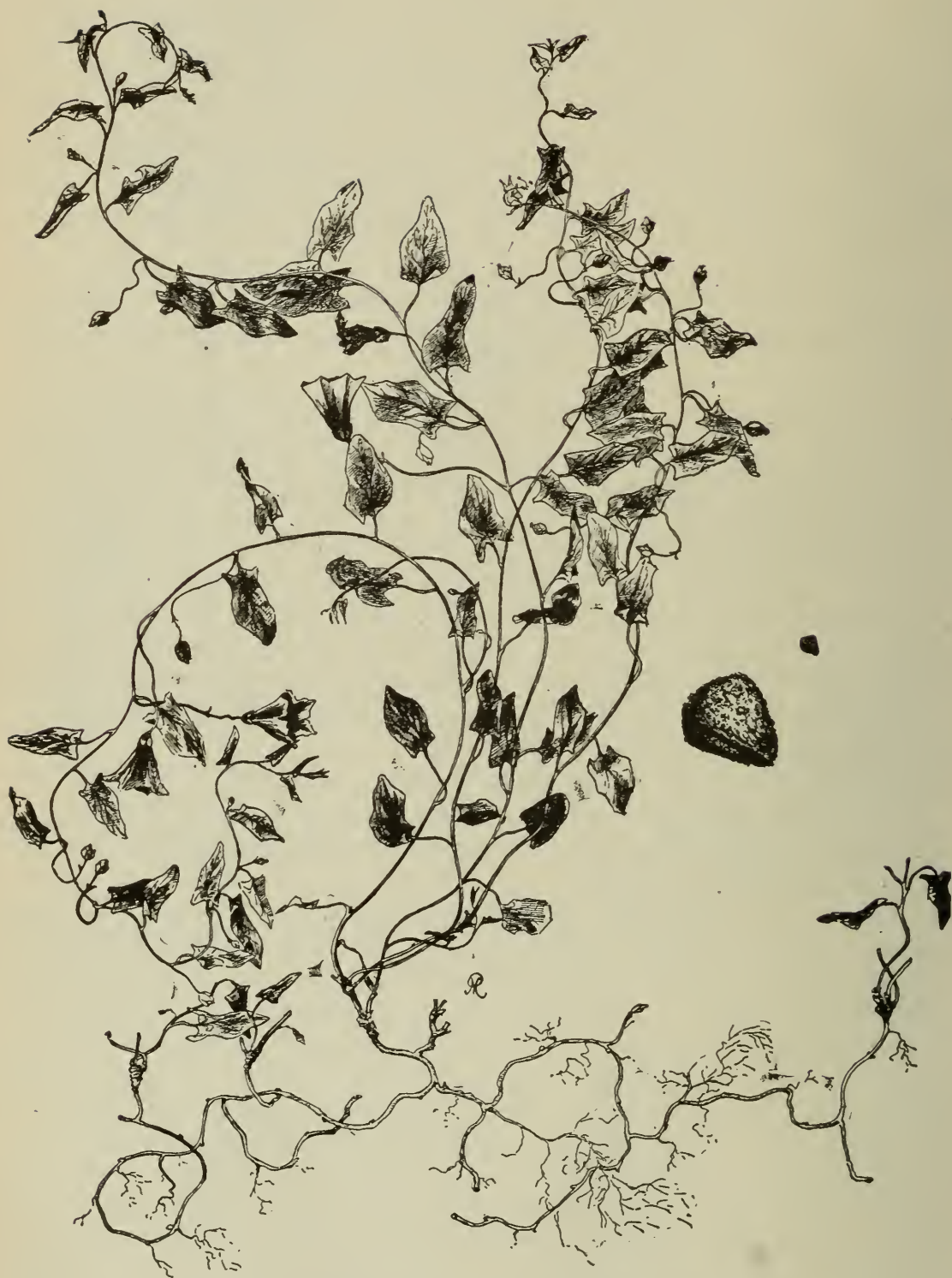


Fig. 36. Field Bindweed (*Convolvulus arvensis*).

(Dwarf Essex variety) or turnips, in drills 26 to 30 inches apart, at the rate of about $1\frac{1}{2}$ pounds per acre. As soon as the crop is up, cultivate every week or ten days until it occupies all the ground and makes further cultivation impossible. If the Bindweed should get started in the rows, hoe it out as completely as possible. This, however, should not be necessary if the previous cultivation has been frequent and thorough. Small patches of bindweed can be destroyed with a chemical weed killer. See Page 115.

DODDER, DEVIL'S GUT OR STRANGLE WEED (*Cuscuta epithymum*, Murr.)
(Fig. 37.)

This is an annual weed introduced from Europe. It appears in clover fields from time to time in Ontario. It has been reported most frequently as occurring in that part of South Western Ontario west of Chatham. A careful watch should be kept for it as it is detrimental to clover seed production and as it is practically impossible to export clover seed containing dodder.

Dodder differs from ordinary weeds in possessing no leaves. The yellow thread-like stems of the plant twine around the clover plants and send into their tissues small short rootlets, which are called suckers or haustoria. By means of these suckers the Dodder draws from the clover the food necessary for its growth and reproduction. It thus kills the clover by robbing the plant of this food and causing it to starve. The yellow thread-like stems of the Dodder first appear quite early in the season. They soon spread from plant to plant until a tangled mass of yellow threads covers a whole patch of clover. Badly infested fields may become entirely covered with this pest in a short time. On these yellow threads are produced dense clusters of small white flowers, which are succeeded by rounded, brown seed pods. Each plant produces a large number of seeds. The seeds vary in size from $1/24$ to $1/15$ of an inch; are grey or yellowish brown in colour, vary greatly in shape, but are generally somewhat oval in outline, and the surface is dull and roughened.

Control. As soon as Dodder is noticed the infested patches should be mowed, and the refuse raked up and burned. Badly infested fields should be plowed before the Dodder has time to form seed, or the crop may be cut early for hay and the land plowed. Care should be taken to secure clover seed, free from Dodder.

THE BORAGE FAMILY (*BORAGINACEAE*)

BLUE BUR, STICKSEED, OR SHEEP BUR (*Lappula echinata*, Gilbert)

A disagreeable weed on roadsides, in waste places and in pastures. The burs become matted in the wool of sheep.

An introduced annual and winter annual. Erect and branching, covered with rough hairs. Leaves linear oblong, stem-leaves without stalks. Flowers small, $\frac{1}{8}$ inch across, pale blue in long, slender one-sided clusters. Seeds greyish brown in colour, pear-shaped, about $\frac{1}{8}$ inch long, with hooked spines around the margin.

Time of flowering, from June; seeds ripe in July.

Dispersal—By seeds.

Control. In pastures and waste places continued close cutting for a number of years will prevent its seeding and finally cause it to disappear. If a field becomes very badly infested, break it up and put it under a cultivated crop for a year or two. Hand pull stray specimens.



Fig. 37. Field Dodder on Red Clover.
a Flowering Cluster; *b* Cluster of Dry Seeds. From a
 photograph. Natural size.

(Reproduced by the courtesy of the U. S. Dept. of Agriculture, from
 Farmers' Bulletin 306, "Dodder in Relation to Farm Seeds,"
 by F. H. Hillman.)



Fig. 38. Blue Weed (*Echium vulgare*).

BLUE WEED, VIPER'S BUGLOSS, BLUE THISTLE, OR BLUE DEVIL
(*Echium vulgare*, L.) (Fig. 38.)

A biennial weed naturalized from Europe, with deep tap root, which penetrates to a great depth. During the first year, the portion above ground is a rosette of leaves; and from the centre of this, next season, bristly, hairy and erect stems rise 1 to 2½ feet high. The leaves are oblong, 2 to 6 inches in length, with both upper and lower surface hairy. The flowers are numerous, arranged in a rich spire, and are azure blue in colour. The seeds are hard and brown in colour, with a broad base and angular body $\frac{1}{8}$ inch long. (Fig. 38). An average plant produces 3,500 seeds.

Its names, both Latin and English, are significant of the notion that it was an effectual remedy against the bite of a viper.

The weed prefers gravelly and lime soils.

Time of flowering, July-October.

Time of seeding, August-October.

Dispersal—By seeds, especially in winter, when they are blown over the snow.

Control. This weed gives very little trouble in arable land, if the cultivation is at all thorough. In fence corners, on roadsides, and in waste places, cutting below the crown with a spud is practically the only effective method of destroying the weed. Sometimes, however, this is impracticable, because of the number; and in such cases some special treatment, similar to that recommended for the Dock, may be resorted to.

This weed can be destroyed with a chemical weed killer, see page 115.

HOUND'S TONGUE, DOG BUR, OR BURS (*Cynoglossum officinale*, L.) (Fig. 39.)

A biennial weed, with erect hairy stem, of rank growth, and much branched, 1 to 3 feet high. The lower leaves have petioles; the upper ones clasp the stem. They are 6 to 12 inches long and covered with downy hair, and have a disagreeable odour resembling that of mice. The flowers are small and lurid purple-red in colour. The fruit consists of a broad, rounded bur, $\frac{1}{4}$ inch long, with one flat side and covered with short spines which enable it to adhere to clothing or to animals. (Fig. 39). An average plant produces about 600 seeds.

Time of flowering, June-August.

Time of seeding, July-September.

Dispersal—Chiefly by animals carrying the burs.

Control. Spud or cut deep in fall and early spring; the former to destroy the plant in its first year, and the latter to complete the destruction by removing those that escape the first cutting

PIGEON WEED, WHEAT THIEF, RED ROOT, OR CORN GROMWELL
(*Lithospermum arvense*, L.)

A winter annual naturalized from Europe, with reddish roots. It is usually branched, and grows to a height of 12 inches. The leaves are sessile, narrow and harsh to feel. The flowers are small and white; at maturity, four small pitted seeds are produced, which have considerable vitality.

Time of flowering, from April to July.

Time of seeding, from June to August.

Dispersal—Mainly through seed, such as wheat, and rye; often spread by birds and distributed in the manure.



Fig. 39. Hound's Tongue (*Cynoglossum officinale*).

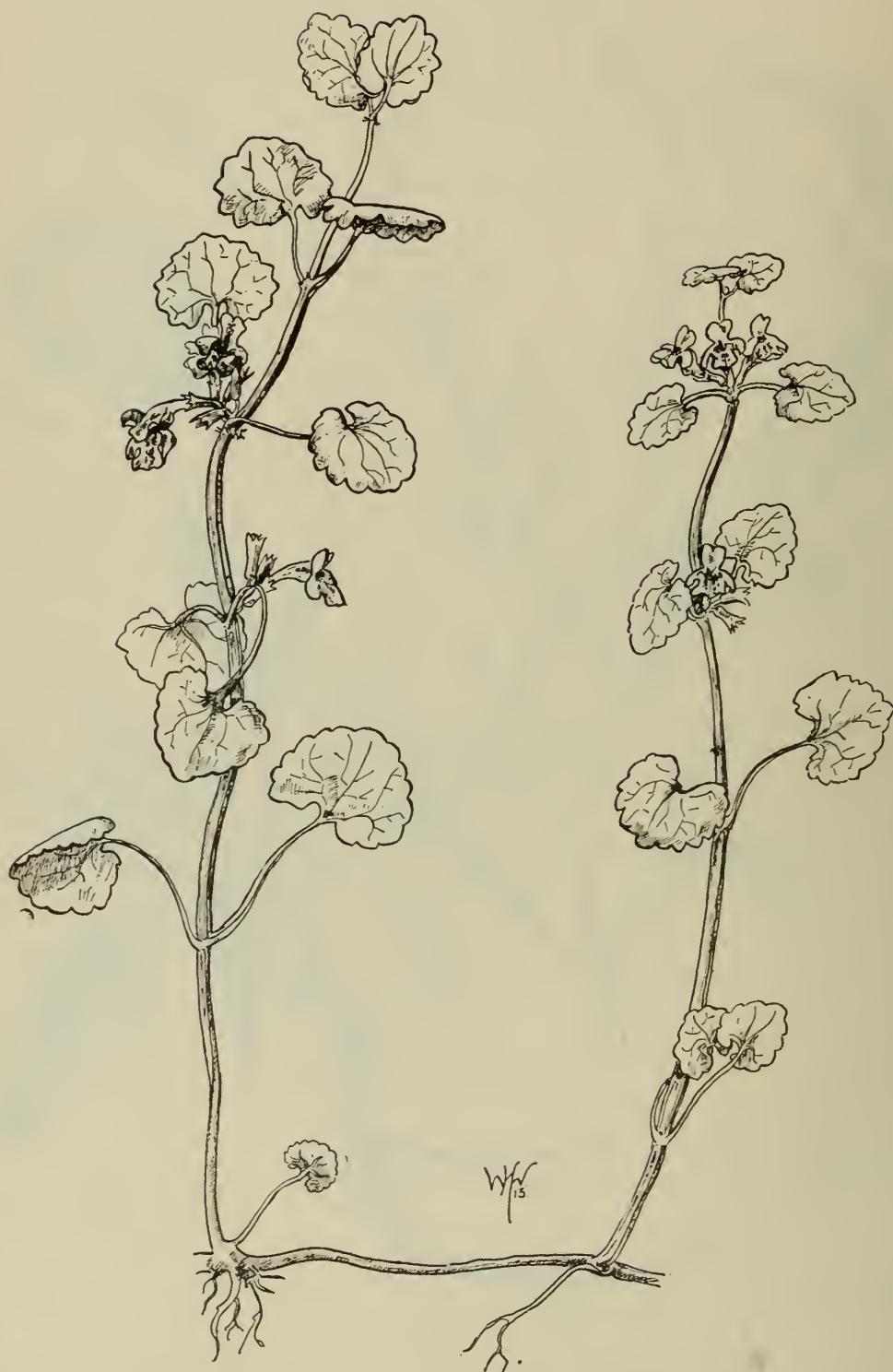


Fig. 40. Ground Ivy (*Nepeta hederacea*).

Control. If this weed is a serious pest adopt a short rotation of crops exclusive of fall wheat and rye. Thorough after harvest cultivation will do much to rid fields of this weed. Plow shallow immediately after harvest and harrow and cultivate frequently.

MINT FAMILY (*LABIATAE*)

GROUND IVY, GILL-OVER-THE-GROUND, CREEPING CHARLIE
(*Nepeta hederacea*, (L). Trevisan) (Fig. 40.)

This little plant is primarily a weed in lawns, where it often becomes very abundant and crowds out the grass. Once established in a lawn, it is very difficult to get rid of.

Ground Ivy is a creeping and trailing perennial weed; leaves small, round, kidney shaped, the margin with rounded teeth; flowers bright blue, two-lipped, in small clusters in the axils of the leaves.

Control. If this weed occurs in the lawn in small patches here and there, cover these with a heavy coating of coarse salt. This will destroy all vegetation. The patches should then be thoroughly raked, removing as completely as possible any roots or stems of the weed which may still remain. Then thoroughly drench the patches with water so as to wash away all the salt, and reseed them with pure lawn grass seed. If the Ground Ivy is all over the lawn the foregoing treatment will not be practicable. The only thing that can be done in such a case, without plowing up the lawn, is to rake and pull out the Ground Ivy as thoroughly as possible early in the spring when the ground is moist. Then stir the surface of the lawn with a coarse rake and reseed with pure lawn grass seed, the object being to get a good thick stand of grass and clover started before the weed begins to grow again. If this is done the Ground Ivy will be prevented from spreading and becoming conspicuous.

THE FIGWORT FAMILY (*SCROPHULARIACEAE*)

MULLEIN, OR VELVET DOCK (*Verbascum thapsus*, L.) (Fig. 41.)

The mullein is a weed introduced from Europe; very common in waste places, roadsides and gravelly or sandy pastures. It is a biennial, with large, long roots, from which spring a tall and usually unbranched stem, 2 to 6 feet high. Both stem and leaves are densely woolly all over, with branched hairs. The leaves are whitish, thick and velvety to the touch. The flowers are yellow and arranged on densely crowded elongated spikes. The capsule containing the seeds is about $\frac{3}{8}$ inch long, and the seeds are small, about $\frac{1}{20}$ inch long, six sided, with irregular ridges running lengthwise between the pits. The colour of the seed is dark brown. An average plant produces 6,000 seeds.

Time of flowering, July-September.

Time of seeding, August-November.

Dispersal—As an impurity in clover and grass seed.

Control. Mullein will not withstand cultivation and gives little trouble in fields under a short rotation of crops. Plants in permanent pastures and waste places should be cut below the ground each year when they appear.



Fig. 41. Mullein (*Verbascum thapsus*).

The Moth Mullein (*Verbascum blattaria*, L.) is a worse weed than common mullein, as it infests meadows and bears far more seed. The seed is often found as an impurity in clover and timothy. The plant itself is smooth and slender, from 2 to 6 feet high, with dentate leaves. The flower is yellow, with brown marks on the back of the petals; and the stamens have violet filaments. The seed is brown, very small, and six-sided. Treat it the same as common mullein. In Fig. 41, are shown the seeds of the mulleins, the lower is the moth mullein, the upper seed is the common mullein.

TOAD FLAX, OR BUTTER AND EGGS (*Linaria vulgaris*, Hill) (Fig. 42.)

This weed has become very plentiful in Ontario, and is now found in many pastures, on roadsides and in waste places.

It is a deep-rooted, persistent, perennial weed. The stem is slender and erect, somewhat wiry, and from 12 to 18 inches high. The leaves are narrow, stalkless and scattered along the stem at very short intervals. The flowers are showy, distinctly two-lipped, about 1 inch long, bright yellow in colour with orange lips and borne in a long terminal cluster (raceme). The seeds are dark brown or black in colour, about 1/10 inch in diameter, flat and disc-like, with a distinct wing around a thicker central portion which is roughened with little projections.

Time of flowering, June to September; seeds ripe by August.

Dispersal—By seeds and root-stocks.

Control. Adopt a short rotation of crops and give thorough deep cultivation in spring and fall. Hand pull when the soil is wet in pasture lands which cannot be broken up. Break up badly infested pastures in July, keep under clean summer fallow until fall and put in a hoed crop the following season.

THE PLANTAIN FAMILY (*PLANTAGINACEAE*)

COMMON PLANTAIN (*Plantago major*, L.) (Fig. 43.)

A weed of meadows and lawns, the seeds of which are too often found in grass and clover seed.

A perennial with a short, thick rootstock bearing numerous large, dark green, oval, long-stalked leaves close to the ground. Flowers inconspicuous, borne in long dense spikes. Seed pods oval, dividing about the middle and containing from eight to sixteen small, flat, irregularly-shaped brown seeds.

Control. A short rotation including a hoed crop will keep this weed in check. *"Plantain in lawns may be weeded out when the soil is firm by forcing a small implement like a chisel, with a half-rounded blade having a point like the tip of a spoon, between the soil and the fleshy crown of the weed to a depth sufficient to break the plant away from its fibrous roots without disfiguring the turf."

PALE PLANTAIN, OR RUGEL'S PLANTAIN (*Plantago rugelii*, Dene.)

This Plantain is found as frequently as Common Plantain, from which it can be distinguished by the paler green leaves with the stalks dark purple at the base, the longer and more tapering spikes with the flowers less crowded, and the seed pods, which open below the middle and contain from four to nine flat, irregularly-shaped black seeds, which are larger than the seeds of the Common Plantain.

* Farm Weeds of Canada



Fig. 42. Toad Flax, or Butter and Eggs (*Linaria vulgaris*).



Fig. 43. Common Plantain (*Plantago major*).

RIBGRASS, BUCKHORN, ENGLISH PLANTAIN, RIBWORT
(*Plantago lanceolata*, L.) (Fig. 44.)

This is a weed which has been introduced into this country from Europe. It is often very troublesome in lawns and clover fields. It is especially troublesome in red clover. At the present time it is very hard to get red clover seed free from the seeds of ribgrass. This is a perennial or biennial weed with a very thick root stock from which the leaves spring. These sometimes grow erect; more generally they lie on the ground as a rosette. At the base of the leaves there are tufts of brown hair; and the leaves themselves are long, narrow and tapering, with prominent veins, or ribs running lengthwise; hence some of the popular names. This flower-stalk is slender and channelled, is without leaves and terminates in a dense spike. The stamens project from the inconspicuous flowers, giving a whitish appearance to the whole head. The seeds are enclosed in small pods, each containing two seeds. The seeds are about $\frac{1}{12}$ of an inch long, brown and shiny, with a groove on one side, in the centre of which there is a black spot. The opposite side is rounded, as are also the ends. An average plant produces 1,200 seeds.

Time of flowering, June-September.

Time of seeding, July-September.

Control. Sow pure seed. If the plants are not numerous cut below the crown with a spud. If they are, break up the field and put in a hoed crop. A short rotation



Fig. 44. Ribgrass (*Plantago lanceolata*).

of crops will soon suppress this weed. It is very common in clover fields and it is hard to obtain clover seed free from the seeds of this weed. It is advisable to purchase only the best grade of clover seed. If the weed appears in a clover seed crop, pull the plants or the seeds will depreciate the market value of the clover seed. Special screens are required to separate this seed from Red Clover seed. Small quantities can be cleaned by spreading the clover seed on damp canvas. The plantain seeds will stick to the cloth and the clover seed will drop off when the canvas is inverted.

THE SUNFLOWER FAMILY (*COMPOSITAE*)

CANADA FLEABANE, HORSE WEED, OR BUTTER WEED

(*Erigeron canadensis*, L.) (Fig. 45.)

A tall, hairy plant, very common in meadows. It is a winter annual. The stem is much branched, hairy and may vary from 3 inches to 10 feet in height. The leaves are downy, from 1 to 4 inches long. The flower heads are numerous, about $\frac{1}{8}$ inch broad. The seeds are small, light in colour, and $\frac{1}{16}$ inch long, with a pappus of short tufty hairs. An average plant produces 120,000 seeds (Kerner).

Time of flowering, June-September.

Time of seeding, June-September.

Dispersal—Chiefly by the wind.

Control. Having a small root, this weed can be pulled easily. Hence, where there is not very much of it, hand-pulling is a satisfactory means of eradication. As a rule, the weed is troublesome only in meadows, and the frequent breaking up of meadow lands tends to keep it under control.

TALL DAISY FLEABANE (*Erigeron annuus*, L.) has larger and fewer flower-heads, $\frac{1}{2}$ inch across. It is common in meadows and along roadsides from May to November.

GREAT RAGWEED, OR KINGWEED (*Ambrosia trifida*, L.) (Fig. 46.)

A weed in Western grain fields and in waste places in Ontario. A rough, coarse-growing annual weed from 3 to 6 feet high, with large opposite leaves which are mostly three-lobed. The flowers are of two kinds, the sterile borne on tapering spikes about 4 inches in length; the seed-producing flowers grow close to the stem in clusters in the axils of the leaves at the base of the spikes; sterile flowers $\frac{1}{4}$ inch across, cup-shaped, nodding; stamens yellow and conspicuous. Seed-producing flowers inconspicuous with slender purplish pistils.

Time of flowering, July; seeds ripe by August.

Dispersal—By seeds. Wheat from districts of the West often contains Great Ragweed seed.

Control. Hand pulling and mowing.



Fig. 45. Canada Fleabane (*Erigeron canadensis*).



Fig. 46. Great Ragweed (*Ambrosia trifida*).

RAGWEED, HOGWEED, BITTERWEED OR ROMAN WORMWOOD
(*Ambrosia artemisiifolia*, L.) (Fig. 47.)

Ragweed is an annual. The stem is much branched and slightly hairy, from 1 to 3 feet high. The leaves are very finely divided, the lower surface being of a lighter colour than the upper. The flower heads are very numerous, from 1 to 6 inches long, green and inconspicuous. The flowers are yellow, $\frac{1}{8}$ inch across, infertile in the terminal spikes and fertile only at the base of the spikes. The seed is dark brown, about $\frac{3}{16}$ of an inch long, somewhat top-shaped with sharp tip around which are arranged 4-6 spines. They have great vitality and remain in the soil a long time without injury. An average plant produces about 5,000 seeds. The weed has a bad taste and gives a peculiar odour to the milk of cows which eat it.

Time of flowering, July-September.

Time of seeding, August-November.

Dispersal—As an impurity in seed grain and clover seed; and by wind and water, being borne long distances by freshets.

Control. For the eradication of this weed, special attention must be given to the fall cultivation of the soil, to prevent seeds from ripening. Gang-plow or cultivate, and harrow stubble ground immediately after harvest, and repeat cultivation at intervals until late in the fall; then plow or rib up, and follow with a hoed crop. Care should be taken with the hoed crops that no specimens of Ragweed go to seed. When in grass, go over with a mower in September or October, if any plants are likely to mature seed. Do not sow late maturing crops.

YELLOW DAISY, CONE-FLOWER, BLACK-EYED SUSAN, OR NIGGERHEAD
(*Rudbeckia hirta*, L.) (Fig. 48.)

A biennial and sometimes annual weed found in pastures and meadows. It grows about 1 to 3 feet high. The stems are sparingly branched and very bristly. The leaves are thick, hairy, oblong and tapering towards the point. The flower head is about 1 inch across, with orange yellow rays or "petals" (ten to twenty in number), and dark purple brown discs almost spherical or cone-shaped. The seeds are dark brown, almost black, four-angled, and about $\frac{1}{8}$ inch long, with no pappus, or tuft of hair. (Fig. 48). An average plant produces about 2,000 seeds.

Time of flowering, June-August.

Time of seeding, July-September.

Dispersal—As an impurity in timothy.

Control. Cutting or mowing this weed each year in permanent pastures or meadows will suppress it. It never gives serious trouble on land under a short rotation of crops. Sheep in sufficient numbers will cause this weed to disappear from pasture lands.

OX-EYE DAISY, WHITE DAISY, WHITE WEED, OR POVERTY WEED
(*Chrysanthemum leucanthemum*, L.) (Fig. 49.)

The Ox-eye Daisy is a weed naturalized from Europe, and is very closely related to the *Chrysanthemum* or national flower of Japan.



Fig. 47. Ragweed (*Ambrosia artemisiifolia*).



Fig. 48. Cone Flower (*Rudbeckia hirta*).



Fig. 49. Ox-eye Daisy (*Chrysanthemum leucanthemum*).

It is a perennial with short, thick rootstocks, possessed of much vitality. Very many stems spring from one root. It grows from 6 inches to 3 feet high. The leaves slightly clasp the stem, the lower ones narrow, long, and toothed along the edges, the upper ones small and without teeth. They are slightly aromatic, more perceptibly if bruised. The "flowers" are 1 to 2 inches broad, on long stalks, with from twenty to thirty white rays and a bright yellow disc. The seed is grey and white or black and white, somewhat club-shaped with a small knob at the large end about $\frac{1}{12}$ of an inch in length, surface with 12 slender conspicuous white longitudinal ribs.

Time of flowering, June-August.

Time of seeding, June-September.

Dispersal—Chiefly in grass seeds and by birds.

Control. The Daisy is most troublesome in pastures, and can be got rid of only by cultivation. If the field is in sod (meadow or pasture) plow shallow (not more than 4 inches) towards the end of August and harrow at once. Let it stand a couple of weeks and cultivate it the same way it was plowed, 2 or 3 inches deep. After a while cultivate a little deeper. If possible, cultivate a third or even a fourth time, going a little deeper each time. Then, if you can manage to do so, rib up with a double mould board plow the last thing in the fall. In the spring cultivate the field often enough to keep the Daisy from making any growth above ground until it is time to put in potatoes, corn, roots, or rape. The hoed crop must be repeatedly and thoroughly cultivated in order to be effective.

If the field was plowed last fall, this spring cultivate thoroughly until about the middle of June, running over it frequently with the cultivator so as to keep the tops down and thus weaken the "roots." Then apply manure at the rate about twenty tons per acre (twelve good loads). Cultivate the manure in thoroughly and with a double mould board plow slightly ridge up the land making the ridges about 26 inches apart. On the ridges sow pasture rape (Dwarf Essex variety) at the rate of $1\frac{1}{2}$ pounds per acre. It is important that the right amount of rape should be sown. Sow the rape when the land is sufficiently moist to insure quick germination of the seed. Cultivate the rape every week or ten days until it occupies all the ground and makes further cultivation impossible. When the rape is cut or pastured, there should be none of the Ox-eye Daisies left in the field. See Chemical Weed Killers, Page 115.

COMMON RAGWORT, TANSY RAGWORT, OR STAGGERWORT (*Senecio jacobaea*, L.) (Fig. 50.)

This plant has been sent to the Department on one or two occasions from the neighborhood of Guelph. It has probably been reported before as occurring in Ontario, since it is mentioned in the official list of the Toronto Educational Department Herbarium, but as it is not recorded, to our knowledge, in any other list, it is for all practical purposes a plant new to the Province.

This is the weed which has caused so much trouble in the Eastern Provinces. It is a very dangerous weed because, when eaten by cattle, it causes a curious and fatal disease of the liver (*Hepatica cirrhosa*). For this reason farmers should keep a sharp lookout for it, and destroy it whenever it appears. It is easily recognized being a large, conspicuous, strong growing plant, about 2 to 3 feet high. The flowers are in numerous heads in corymbose clusters, bright yellow in colour and very showy. The

root leaves are 6 to 8 inches long, petioled. Stem leaves sessile and clasping, all leaves dark green, deeply twice pinnatifid, the segments crowded and overlapping, crisped and waved.

Control. If they are not too numerous, grub out the plants, roots and all. If they are numerous plow up the field and bring it under a short rotation of crops. If on land that cannot be broken up, cut the weed in time to prevent it from seeding for several successive years. Keep cattle off fields in which this weed is growing.

LESSER BURDOCK, BUR, CLOT-BUR, OR BEGGAR'S BUTTON (*Arctium minus*, Bernh.) (Fig. 51.)

A biennial weed with tremendous roots, probably the largest of all weed roots. This root is uniform in size for a foot below the surface; farther down it is much branched and has a great hold on the ground. The stem is much branched (from 4 to 6 feet high) and rough, with broad rounded leaves, the lower surface of a lighter green than the upper. The flower heads occur in clusters and are purple in colour. The flower receptacle, or involucre, as it is called, is composed of hooked spines, which are very adhesive, and do much injury to the wool of sheep. The seeds are brown, $\frac{3}{8}$ inch long and spotted with darker brown (Fig. 51).

Time of flowering, July-September.

Time of seeding, August-October.

Dispersal—Chiefly by animals carrying the seed from place to place.

The plant when burned yields a good quality of alkaline ash, equal to the best potash; and a decoction from the roots is said to be equal to the juice of Sarsaparilla as a blood purifier, etc.

Control. Cut below the ground with a spud and burn the tops. A handful of salt applied after cutting in hot dry weather will kill this plant.

CANADA THISTLE, OR CREEPING THISTLE (*Cirsium arvense* (L.), Scop.) (Fig. 52.)

This weed was originally introduced from Europe, and hence is incorrectly named Canada Thistle. It is a hardy perennial, with numerous underground stems which bear a large number of shoots. (See Fig. 52, illustrating two of these shoots.) It grows to a height of 1 to 3 feet. The leaves are narrow and long, deeply indented into very prickly, lobed segments. The leaf has a crimped appearance, and at the base slightly clasps the stem. The under surface of the leaf is woolly, the upper surface less so. It produces numerous heads, which are $\frac{1}{2}$ to $\frac{3}{4}$ inch across and of a lilac-purple colour. The flower head is smaller than that of other thistles. The seed is grey, oblong, and about $\frac{1}{8}$ inch long, with slight longitudinal markings. Attached to the top is a conspicuous tuft of long hair (the pappus) (Fig. 52). The seed is carried long distances by the wind. An average plant produces 3,500 seeds.

Time of flowering, June-August.

Time of seeding, July-September. Many plants produce no seed.

Dispersal—Chiefly by the wind.

Great care should be taken to prevent Canada Thistle from seeding.

Control. The Canada Thistle can be controlled in several ways, if thorough work is done at the right time.

1st. By a regular short rotation of crops with thorough cultivation. A good rotation is one of clover, hoed crops and cereal crops. First year two cuttings of early red clover followed by deep plowing and cultivation. Second year, hoed crops with clean cultivation. Third year, a cereal crop seeding down again with clover.



Fig. 50. Ragwort, Tansy Ragwort or Staggerwort (*Senecio jacobaea*).

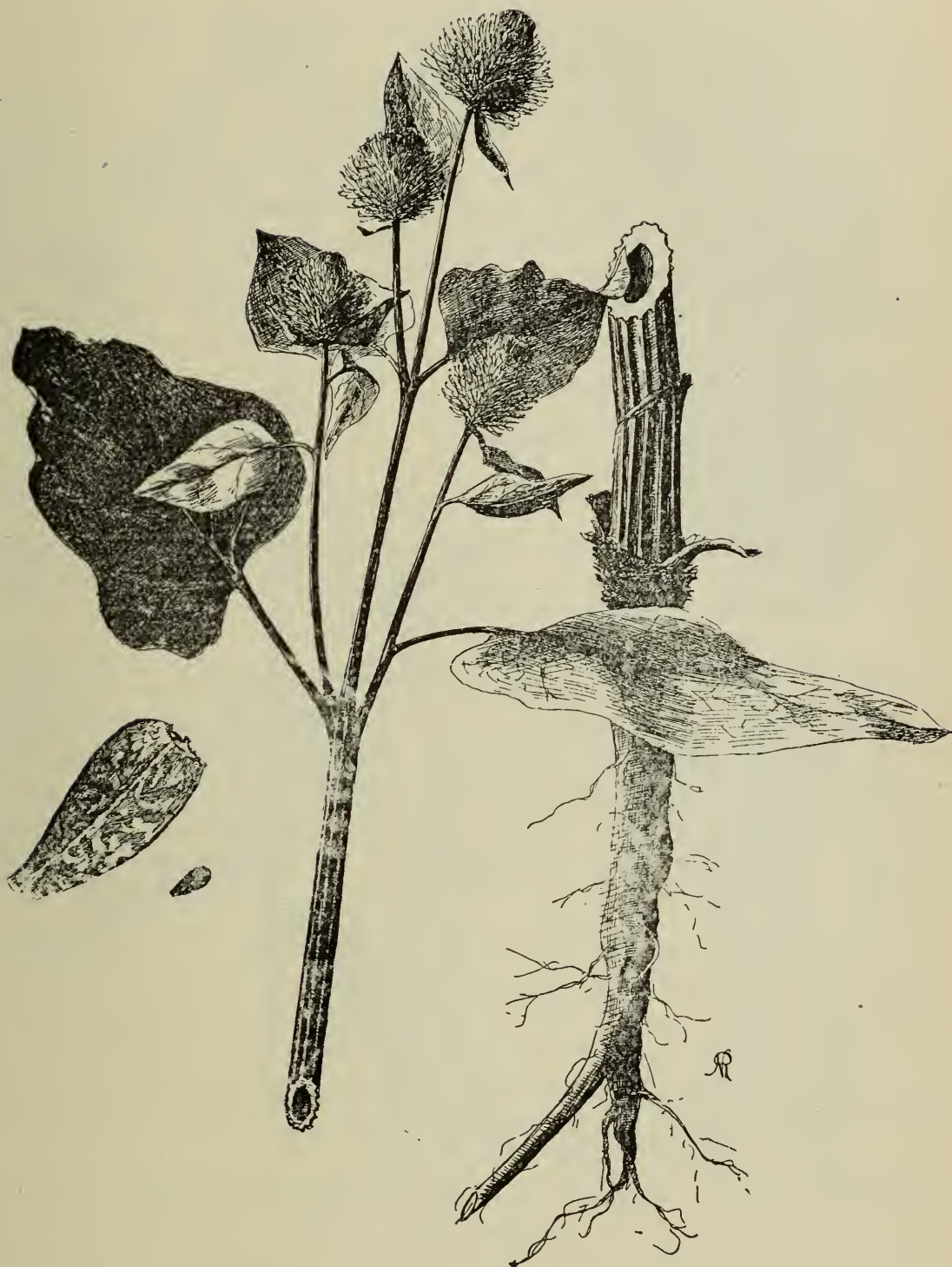


Fig. 51. Burdock (*Arctium minus*).

2nd. By summer fallowing. Plow deeply in the summer just as the flowers begin to open. Cultivate at intervals with a broad-shared cultivator, so as not to let the thistle get any growth above the ground during the growing season.

3rd. By Method No. 1 for Perennial Sow Thistle described on page 107.

CHICORY, OR WILD SUCCORY (*Cichorium intybus*, L.) (Fig. 53.)

A perennial weed introduced from Europe, with long, deep tap-root, which when dried and ground up is used in adulterating coffee and as a substitute for it. The stems are almost leafless, from 1 to 3 feet high, much branched, slightly hairy and whitish in colour. The leaves, spread out on the ground, are long with irregular edges. The flower heads are numerous, occurring in clusters, without flower stalks, on the naked branches. The "flowers" are about $1\frac{1}{2}$ inches across, bright blue in colour, and are usually closed by noon. The seed is about $\frac{1}{8}$ inch long, tapering to a blunt point, the opposite end having a fringe of minute scales around the crown. The body of the seed is corrugated. An average plant produces about 3,000 seeds.

Time of flowering, July-October.

Time of seeding, August to October.

Dispersal—Frequently as an impurity in clover and grass seed.

Control. Seldom troublesome in well cultivated fields. A short rotation of crops will soon cause it to disappear. Badly infested fields may be cleaned by deep, thorough fall cultivation, followed by a hoed crop the next season.

FALL DANDELION OR AUGUST FLOWER (*Leontodon autumnalis*, L.) (Fig. 54.)

An introduced perennial weed reported recently from several places in Ontario as occurring in hayfields. Leaves mostly basal, springing from a short thick rootstock and resembling somewhat the leaves of the Common Dandelion. Stems branched, scaly and few flowered. "Flowers" about 1 inch across, bright yellow. Seed is $\frac{1}{4}$ inch long, brown, linear, ribbed lengthwise and bears a row of feathery bristles about its own length. (Fig. 54.)

Time of flowering, July till frost; seeds ripe by August.

Dispersal—By seeds and by division of the crown.

Control. *"Badly infested fields should be brought under cultivation. Pasture lands that cannot be cultivated may be improved by severely raking the surface with a spring-tooth harrow and sowing the most vigorous grasses."

YELLOW GOAT'S-BEARD, MEADOW OR WILD SALSIFY (*Tragopogon pratensis*, L.) (Fig. 55.)

This is a weed common along roadsides, railway tracks, and in waste places in many parts of Ontario. No reports have been received of it persisting in cultivated fields. However, specimens are frequently sent into the Department of Botany for identification, as it is a very conspicuous plant both in flower and seed. Fig. 55.

Yellow Goat's-Beard is a perennial weed naturalized from Europe. It has a long, slender tap root; and upright stem from 1 to 3 feet high; leaves keeled, long narrow, taper-pointed; large yellow flower heads, from 1 to $2\frac{1}{2}$ inches broad, which

*"Farm Weeds" by G. H. Clark.



Fig. 52. Canada Thistle (*Cirsium arvense*).

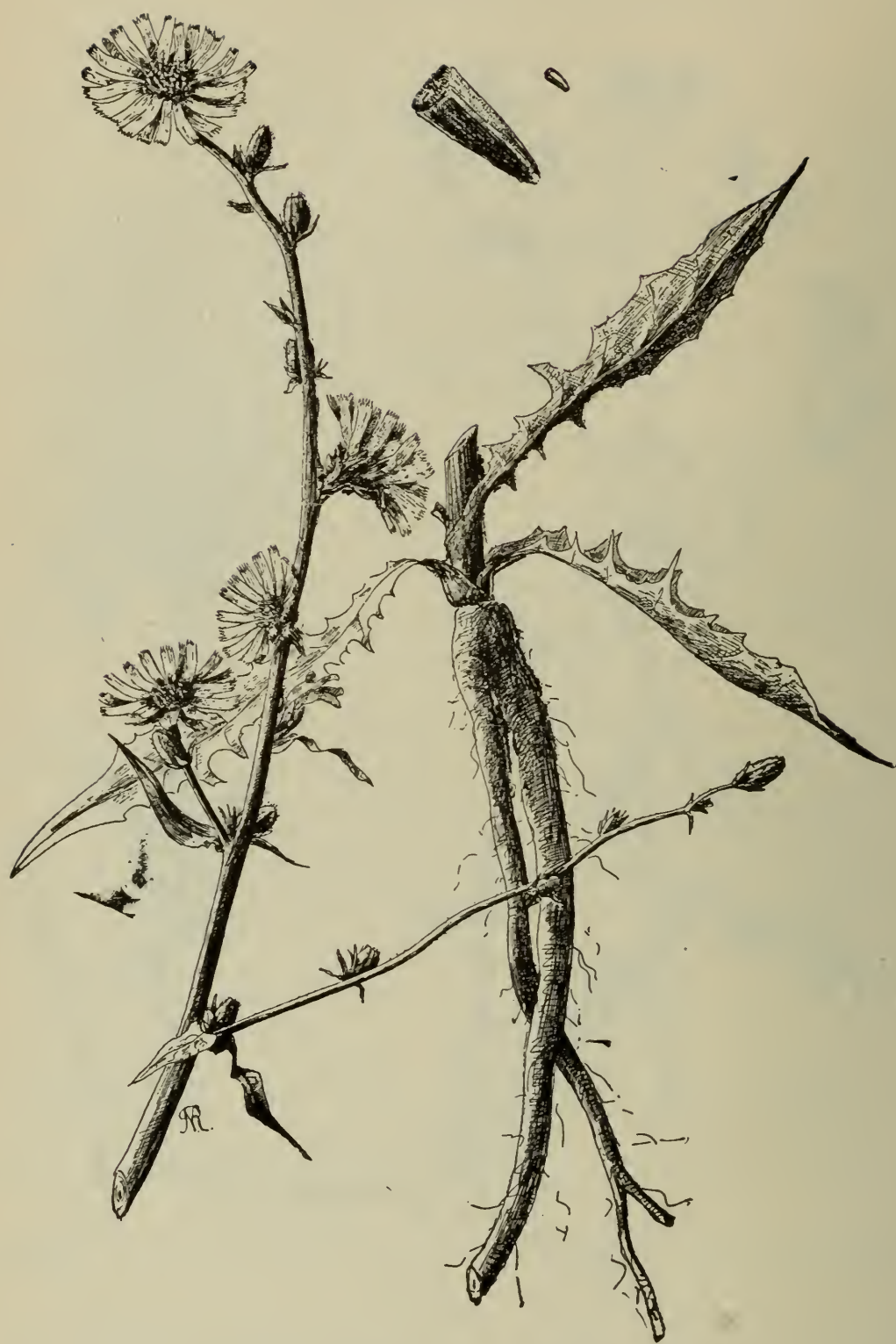


Fig. 53. Chicory (*Cichorium intybus*).



Fig. 54. Fall Dandelion (*Leontodon autumnalis*).

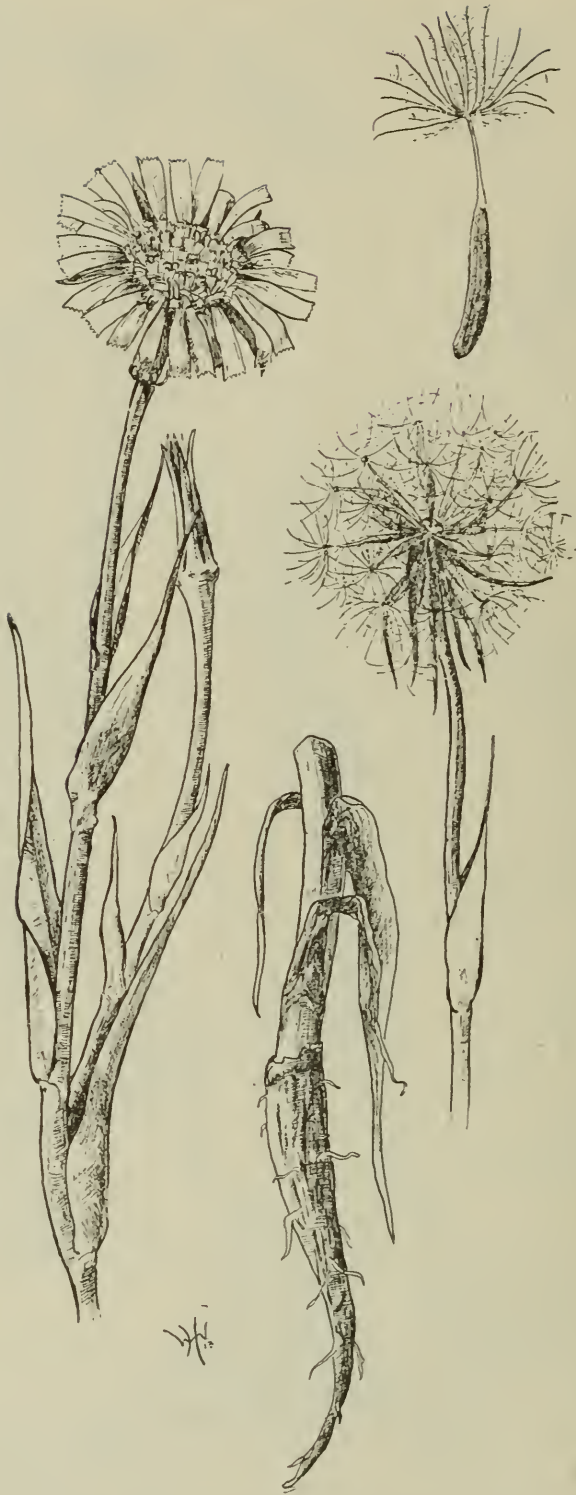


Fig. 55. Yellow Goat's-Beard (*Tragopogon pratensis*).

are succeeded by conspicuous spherical heads of downy seeds looking like very large dandelion seed-heads. The seeds are yellowish-brown, long and slender, somewhat spindle-shaped, tapering to a slender beak which bears a tuft of hairy bristles; the surface is lined lengthwise and somewhat roughened with little projections. The whole plant is filled with a milky juice.

Time of flowering, from June to September.

Time of seeding, from July to September.

Control. This weed does not appear to stand cultivation, as it is seldom seen in fields which are under crop. If it becomes abundant in meadows or pastures, breaking these up and keeping them under cultivation for a year or two should cause it to disappear. Stray plants on roadsides, head-lands and waste places should be cut early enough to prevent them from seeding.

SALSIFY, OYSTER PLANT, PURPLE GOAT'S-BEARD (*Tragopogon porrifolius*, L.)

This plant, which is cultivated as a vegetable, is often found growing on roadsides and waste places. It is very similar to Yellow Goat's-Beard except for the colour of the flower-heads, which is purple instead of yellow.

THE PERENNIAL SOW THISTLE (*Sonchus arvensis*, L.)

This is by all means the worst weed in the Province of Ontario at the present time. It is no exaggeration to say that Perennial Sow Thistle is a menace to Ontario agriculture. In certain sections of many counties it has made profitable crop production extremely difficult. Some idea of the sow thistle situation in Ontario may be had from a survey of the Province made through the cooperation of the Agricultural Representatives. A glance at a summary of this survey reveals these obvious facts: (1) that Perennial Sow Thistle is in every county and district in the Province; (2) that in twenty-two counties there are one or more heavily infested areas; (3) that in twenty-four counties, Perennial Sow Thistle occurs in every township; (4) that sixteen counties have only medium or light infestations of Perennial Sow Thistle; (5) that while sow thistle is by no means confined to heavy and clay loam soils, the great majority of widespread and serious infestations occur in areas where these soils are the prevailing types; (6) that many of the worst infestations occur in districts where the drainage is poor.

In spite, however, of the wide dispersal of Perennial Sow Thistle, there are many who are not able to recognise this pest and who mistake it for its two comparatively harmless cousins, the Common Annual Sow Thistle and the Spiny Annual Sow Thistle. This should not be the case, as it is a very conspicuous weed and differs markedly from the other two species.

The Perennial Sow Thistle is a tall, coarse growing perennial weed with numerous underground "roots" or "rootstocks." Upon these at intervals are borne buds which develop into new plants. The stem is comparatively smooth and hollow and the whole plant is filled with a bitter milky juice. The leaves are from four to twelve inches long, deeply cut with the segments pointing backwards (runcinate), slightly prickly. The flowers, or more correctly speaking, the heads of flowers are deep yellow in colour and one and a half inches or more across. The involucre, or as it is commonly called the flower cup, and the peduncles or flower stems are covered with distinct, yellow glandular bristles. The seeds are dark reddish-brown in colour, about one-eighth of an inch long, somewhat spindle shaped, with blunt ends, and each surface is deeply and closely ridged lengthwise; the ridges cross wrinkled. Each seed bears a tuft of white, silky hairs, (pappus) which, when dry, acts as a parachute and enables the seed to be borne long distances by the wind. Fig. 56.



Fig. 56. Perennial Sow Thistle (*Sonchus arvensis*).

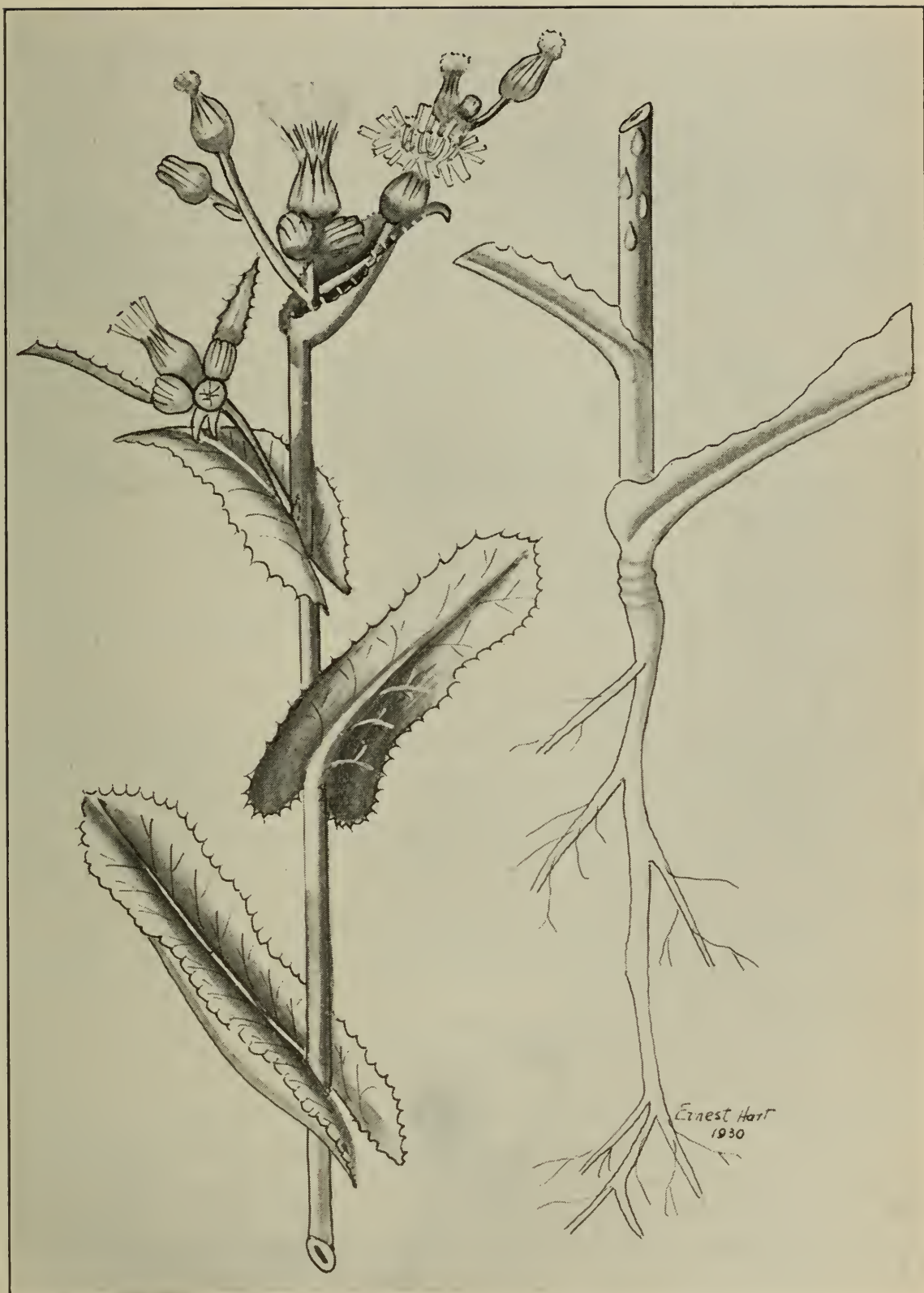


Fig. 57. Spiny Annual Sow Thistle (*Sonchus asper*).

Time of flowering, June to August.

Time of seeding, July to October.

Dispersal—By wind borne seeds and running root stocks.

POINTS OF DISTINCTION BETWEEN PERENNIAL SOW THISTLE AND THE ANNUAL SOW THISTLES

(1) The Perennial Sow Thistle is a taller and more slender plant than either of the other two sow thistles.

(2) The Perennial Sow Thistle has numerous underground "roots" while the Annual species have only fibrous roots. (See illustrations.)

(3) The leaves of the common Annual Sow Thistle are deeply cut and lobed, and scarcely spiny. The leaves of the spiny Annual Sow Thistle are wavy on the margin, prickly and often decidedly waxy. The leaves of the Perennial Sow Thistle are deeply cut with the segments pointed backwards and slightly prickly (see illustrations).

(4) The "flowers" of the Perennial Sow Thistle are deep yellow in color and an inch and a half or more across, while the "flowers" of the annuals are pale yellow in color and less than an inch in diameter.

(5) The flower cups (involucre) and flower stems (peduncles) of the Perennial Sow Thistle are copiously covered with short glandular bristles while those of the annual species are nearly smooth.

GENERAL SUGGESTIONS FOR CONTROL

(1) Watch for the first patches of Sow Thistle in the field and destroy them before they become established.

(2) Be careful not to harrow or cultivate through patches and drag the underground "roots" all over the field.

(3) A few patches of Perennial Sow Thistle if allowed to mature may seed down a whole neighborhood. Therefore take every precaution to prevent the seeding of patches in meadows, grain fields, fence corners and on the roadside.

(4) Cut the Sow Thistle to prevent it from seeding, just as soon as the first few "flowers" appear. Blossoms over five days old may develop viable seed after the plants are cut.

(5) Cultivating in dry weather is most effective in Sow Thistle control.

(6) Do not sow a field which is badly infested with Sow Thistle to grain. You will only waste your seed and time.

(7) Pasturing, while it may not kill Perennial Sow Thistle, holds it in check and prevents it from spreading. If possible pasture every spot on the farm that is hard to control.

(8) Sheep are fond of Perennial Sow Thistle and if turned on a field after harvest will prevent it seeding and by close cropping weaken the underground "roots."

(9) The Perennial Sow Thistle thrives most luxuriantly on rather low damp land. Underdrainage therefore, is a great help in controlling it.

(10) It is better to use low-lying undrained fields for pasture or hay rather than for grain crops.

(11) Crop rotation is of utmost importance in dealing with the Perennial Sow Thistle. Some sharp short rotation of crops should be adopted which will allow the frequent use of the cultivator during the dry weather of July and August, the cutting of the "flowers" before seeding, and the introduction of a smother crop or hoed crop.

(12) In summer fallowing for Perennial Sow Thistle, never let the thistle show above the ground. A bare or black fallow is the only effective one.

(13) Where soil fertility has been maintained by the judicious use of commercial fertilizers or well rotted manure, the crop grows so vigorously that it appears to check the spread of the Sow Thistle.

CHEMICAL WEED KILLERS FOR SMALL PATCHES

Chemical weed killers, especially the chlorates, can be used effectively to destroy small patches of Perennial Sow Thistle. Their cost prohibits their use on large areas. See directions regarding use of chemical weed killers on page 115.

Small patches of Perennial Sow Thistle can also be destroyed by digging out the plants with a fork, roots and all, and burning them. Great care must be taken to get every bit of the "root." The patch should be watched and if new shoots appear, they should be taken out at once. In an ordinary season several diggings will be required in order to exterminate a patch.

DETAILED METHODS OF CONTROL FOR LARGE AREAS

No one method of control is best under all conditions. There are several methods which have been successfully employed, which will be dealt with here. All these methods aim at the destruction of the underground "roots" either by starving them by preventing leaf growth, or drying and baking them by exposure to sun and air. The methods to be employed will depend chiefly upon the nature of the soil, the type of farming practised, the system of cropping that is being followed, and existing weather conditions. Each man concerned should choose that method of fighting the Perennial Sow Thistle that is known to be effective on his kind of soil, and which can be adapted best to his particular system of farming.

A SHORT ROTATION OF CROPS

Follow clover by a crop of grain, then clover again. Cut the first crop of clover in June and plow the land about six inches deep. Let it lie in the rough for about two weeks during hot weather. Then give frequent and thorough cultivation with a cultivator with broad points during the rest of the summer except during wet weather. The following spring sow a grain crop, seeding down with clover. For best results the grain crop should be barley or early oats which can be cut early enough to prevent the Thistle from seeding. The advantage of this system is that it allows of frequent and thorough cultivation during the hottest and driest part of the summer when cultivation is most effective in the destruction of Perennial Sow Thistle.

THE DRY-CLEANING METHOD

This is a method recommended by Agricultural Representative R. H. Clemens who found it effective on heavy clay soils. On such soils it is extremely difficult to control the Perennial Sow Thistle. His suggestions are as follows:

"Plow in July while it is Dry". Take off the hay one week earlier than usual and start plowing the meadow at once. Plow six to seven inches deep, preferably with a two furrowed tractor plow with ten inch bottoms (only), sharp shares and coulter. Three bottom plows or twelve inch plows are not generally practical for hard dry soil. Have the plow adjusted properly.

After the land is dry plowed, it will be very roughly set up with large clods and lumps and holes everywhere in evidence. These newly plowed lands should not be touched for a week or more depending on weather conditions. After some days of exposure to the sun, and while the weather is still hot and dry, start to cultivate and give steady and repeated cultivation as long as the weather remains dry.

Tractor or four-horse cultivators, first with narrow teeth and finally with broad teeth should be used. The heavier the land the heavier the machinery must be to crack the hard soil and break the lumps in dry weather. The tractor has the advantage of speed, and speed cracks the lumps with little difficulty. This method dries out and severely weakens the Sow Thistle roots so that subsequent cultivation kills them.

THE RAPE METHOD

Immediately after harvest gang-plow shallow and run over the field several times with a broad-shared cultivator. Later in the fall plow a little deeper and continue cultivation every week or ten days as long as the season permits. Last thing before the ground freezes rib up the land with a double mold board plow. In the spring work down the ridges and cultivate the field until about the middle of June, running over it frequently with a cultivator so as to keep the tops down and weaken the "roots". Then apply manure at the rate of about twenty tons per acre (twelve good loads). Cultivate the manure in thoroughly and with a double mold board plow slightly ridge up the land, making the ridges about twenty-six inches apart. On the ridges sow pasture rape (Dwarf Essex variety) at the rate of one and a half pounds per acre. It is important that the right amount of rape should be sown for if too little is sown the stand will not be thick enough to smother the weeds, and if on the other hand, too much is sown the plants will be too crowded and not grow vigorously enough to keep ahead of the Thistle. Sow the rape when the land is sufficiently moist to insure quick germination of the seed. If the rape is slow in starting the Sow Thistle may get a start in the rows and thus necessitate hand cultivation there. Cultivate the rape every week or ten days until it occupies all the ground and makes further cultivation impossible. This method requires considerable labour but it is profitable labour as it is very effective. Nearly all our co-operative weed experimenters who have tried this method have found it most satisfactory. Many men hesitate to use rape. This is perhaps because they are not familiar with its agricultural value. Rape has a high feeding value for sheep, hogs and fattening cattle. It is used chiefly for pasture and to some extent as a soiling crop.

SUMMER FALLOW

Directly after harvest plow the land about six inches deep and then give frequent cultivation with a broad-shared cultivator, as long as the season permits. The following spring gang-plow the land and leave in summer fallow until it is time to sow fall wheat. The summer fallow to be effective must be a bare fallow. The field must be cultivated thoroughly and frequently enough to keep the Sow Thistle from making any growth above ground. Bare summer fallow has given excellent results in seasons when other methods were at best only partially effective. In an average season such a summer fallow as that described above, can be depended upon to destroy Sow Thistle. In a very wet season, however, no such method is entirely effective. Summer fallowing for the whole season is often objected to because it is costly. A season's crop is lost, considerable labour is required and valuable plant food materials are leached from the soil. It is often better therefore, to fallow only for a portion of the season, either before putting in a hoed crop or smother crop such as buckwheat, rape or sweet clover, or immediately after breaking up meadows or pastures. Many men are using sweet clover to fight Sow Thistle. They cut it for the silo in June, then plow the field and keep it under bare fallow until it is time to put in fall wheat. They claim that this is an effective way of fighting Sow Thistle.

WINTER RYE AND BUCKWHEAT OR ROOTS

As soon as the grain crop is harvested plow the land and give frequent cultivation with a cultivator with broad points until the first or middle of September. Then sow winter rye at the rate of about two bushels per acre. This can be pastured the following spring or cut for hay or grain. As soon as the rye is off the land, plow about four inches deep. Then cultivate thoroughly and put in rape, buckwheat, or even turnips. The advantage of this system is that three crops are harvested in two years and the Sow Thistle fought at the same time. This method can be used successfully on all except the heavier types of clay soils. Buckwheat is one of the best smother crops that can be used in the control of Sow Thistle.

UNITED ACTION REQUIRED

Many of the best farmers of the Province are fighting Perennial Sow Thistle successfully. Their battle with it, however, is made much more difficult because some men in every neighbourhood are neglecting it and allowing it to go to seed. Millions of plants are allowed to go to seed each year in Ontario and their billions of seeds are scattered far and wide by the wind. Is it any wonder that even some of our best farmers are becoming discouraged by the inroads of the Perennial Sow Thistle? United action is imperative to overcome this menace to Ontario agriculture. Every farmer who has Perennial Sow Thistle on his farm should realize his obligation to his neighbours and himself, and give this weed at least enough attention to prevent it from going to seed.

KNOW THE WEEDS

It is very important that those engaged in farming should get to know the worst weeds and the weed seeds most frequently found in commercial seeds. This they can do with a little trouble. Strange weeds should be sent to the Botanical Department here for identification, and a collection of the most common weed seeds should be secured for reference and comparison.

WEED IDENTIFICATION AND SEED TESTING

The Department of Botany is at the service of farmers, gardeners, seed merchants and others in the identification of weeds, weed seeds, plant diseases, grasses and economic plants. Clover and other farm seeds are tested and reported upon as to purity absolutely free of charge. Plant specimens and samples of seeds should be carefully packed and addressed with postage prepaid to the Botanical Department, Ontario Agricultural College, Guelph, Ontario.



Fig. 58. Annual Sow Thistle (*Sonchus oleraceus*).



Fig. 59. Prickly Lettuce (*Lactuca scariola*).

COMMON ANNUAL SOW THISTLE, OR MILK THISTLE
(*Sonchus oleraceus*, L.) (Fig. 58.)

An annual weed introduced from Europe. It grows 2 to 3 feet high, has fibrous roots and leafy stem, and is not quite so large or coarse as the Perennial Sow Thistle. The leaves are much lobed, and have short, soft spines. Each head is many-flowered; but the "flowers" are small, about $\frac{1}{2}$ inch across, and of a pale yellow colour. The seeds are brown, dull or roughened, and about $\frac{1}{8}$ inch long, with five longitudinal ridges finely wrinkled crosswise, and attached to the top is a large tuft of fine hairs united at the base.

Time of flowering, June-August.

Time of seeding, July-August.

Dispersal—Chiefly by the wind.

Control. Prevent it from seeding in waste places by frequent cutting or by cleaning up such places and seeding them to permanent grasses. After harvest cultivation and a rotation of crops will soon cause this weed to disappear from cultivated fields.

SPINY ANNUAL SOW THISTLE (*Sonchus asper* (L.), Hill) (Fig. 57.)

Very similar in habit and general appearance to the Common Annual Sow Thistle. It can be easily recognized by its more prickly and less deeply cut leaves. The seed is very similar to that of the preceding species in colour, shape and size but distinctly three-nerved on each face with the nerves and inter-spaces smooth.

Control. Same as for preceding species.

PRICKLY LETTUCE (*Lactuca scariola*, L.) (Fig. 59.)

Prickly Lettuce is a native of the old world, and has invaded this Province both from New York and Michigan. It is a winter annual; it springs from seeds in the fall, and survives the winter. The plant grows to a height of $3\frac{1}{2}$ feet; the stem is leafy and usually smooth; the leaves are oblong and slightly pointed, often clasping at the base; the under surface of the midrib of the leaf is spiny: Heads are numerous and yellow.

Time of flowering, July-September.

Time of seeding, August-October.

Dispersal—By means of its seeds, which are provided with a pappus or tuft of hair. An ordinary plant may produce 8,000 seeds.

Control. The best methods of destroying the weeds are: (1) To mow repeatedly as it comes into bloom, or earlier. (2) To cultivate thoroughly with a hoed crop. By this method the seeds in the soil will be induced to germinate. They should not be covered deeply in plowing. Mature plants should be cut down and burned lest the seeds be blown about and scattered by the wind.

Farmers should be careful to buy only clean clover, millet and grass seeds, and the weed inspector should insist on the fulfilment of the law, and have all fence corners, roadsides, and waste lands cleared of the pest.

WILD LETTUCE, SOUTHERN THISTLE, OR TRUMPET-MILKWEED. (Erroneously called Prickly Lettuce.) (*Lactuca canadensis*, L.) (Fig. 60.)

An annual or biennial plant with a leafy stem, which may attain a height of seven feet. The leaves are deeply lobed, terminating in an acute point, and have stalks or petioles, the lower ones being smaller than those near the top of the stem. The stem branches at its summit into a compound flower-cluster. The "flowers"



Fig. 60. Paint Brush (*Hieracium aurantiacum*. L.).

are small, yellow in colour, and open only a few at a time. The seed is dark brown in colour, flat and oval, with longitudinal ribs and thread-like beak at the apex, and possesses a small white tuft of hair.

Time of flowering, June-October.

Time of seeding, July-October.

Dispersal—Chiefly by the wind.

Control. Where there is not much of it, pull and burn before ripening. Where this cannot be done, use the same method as for Mustard.

PAINT BRUSH, DEVIL'S PAINT BRUSH, OR ORANGE HAWK WEED
(*Hieracium aurantiacum*, L.) (Fig. 60.)

This is another weed which is gaining ground in Ontario. Each year it is reported from townships where it has not been observed before. It is spread by means of its tufted seeds which are blown about by the wind and by slender, creeping rootstocks. It grows rapidly and soon crowds out the grass in pasture lands. It is a serious weed when it gets into meadows and pastures, especially those which cannot be broken up and brought under a crop rotation.

It is a perennial weed of European origin, and produces slender runners, which lie near the surface of the soil. The leaves are all basal, and lie close to the ground, forming a rosette. They are broadly-lance-shaped, from 2 to 6 inches in length, the "flower" is orange red in colour, about $\frac{2}{3}$ of an inch in diameter, and borne in clusters on the top of a simple, nearly leafless stem from 12 to 18 inches high. The seeds are provided with tufts of down. When found in clover seed, however, the down is usually absent. They are torpedo shaped, about $\frac{1}{12}$ of an inch long, and ribbed lengthwise. Ripe seeds are dull jet black in colour, unripe seeds deep red.

Control. Paint Brush is but a shallow-rooted perennial and readily succumbs to cultivation. Infested meadows and pastures should be broken up and put under a short rotation of crops. In rocky and upland pastures which cannot be ploughed, small patches of Paint Brush can be kept from spreading by applying salt in hot, dry weather at the rate of 18 or 20 lbs. to the square rod. Spraying with a chemical weed killer which has a Sodium Chlorate base will destroy the hawk weed without permanently injuring the grass. (See page 115.)

Infested permanent pastures may often be improved by sowing a good permanent pasture mixture and by the judicious use of commercial fertilizers.

KING DEVIL (*Hieracium praealtum* Gochnat var. *decipiens* Koch)

This is another pasture and meadow weed. It is troublesome chiefly in Eastern Ontario. It has the general characteristics of Orange Hawk Weed from which it can be distinguished by the small yellow flower heads and by the fact that the whole plant is sparsely hairy and lightly covered with a fine bloom.

Control. Treat the same as Orange Hawk Weed.

CHEMICAL WEED KILLERS

The Botanical Department has carried on an extensive series of field experiments with chemical weed killers for the past three years. In these experiments forty different commercial herbicides and other chemicals were tested, and their effects on twenty-five different kinds of weeds were observed. One thousand plots of weeds of two hundred square feet each, were used in these experiments, and the effects of the various herbicides were studied carefully for a period of three years before any conclusions were drawn or recommendations made.

Many of these chemical weed killers with a sodium chlorate base proved effective, but their cost in most cases prohibits their use on large areas. Some of them, however, are now used effectively, and it is claimed, economically, to destroy weeds on road-sides. The results of our experiments indicate that sodium chlorate can be used economically to destroy large areas of ox-eye daisy and wild carrot in pasture lands. The results of these three years' experiments warrant the following suggestions regarding the use of chemical weed killers.

(1) They are of value, chiefly for the destruction of small patches of persistent weeds.

(2) Use a chemical weed killer with a sodium chlorate base or the pure sodium chlorate, where there is absolutely no danger of fire. A ten to twenty per cent solution (one to two pounds per gallon of water) of these weed killers should be used. If a weed killer with a sodium chlorate base is applied, the rate of application should be one gallon per one hundred square feet; while with the pure sodium chlorate the rate of application should be one gallon per two hundred square feet.

(3) *Perennial Sow Thistle*—Spray the patch twice with a solution of a weed killer with a sodium chlorate base, or with a solution of pure sodium chlorate. Make the first application when the flower buds are well formed, but before any yellow colour is showing in them. Follow this with a second application a month later.

(4) *Blueweed, Burdock, Wild Carrot, Orange Hawkweed, Ox-eye Daisy*: Use one application of a weed killer with a sodium chlorate base or pure sodium chlorate. Spray these weeds a day or so after the first blooms have appeared.

Areas of half an acre or more of wild carrot or ox-eye daisy, may be destroyed by spraying sodium chlorate, at a cost of approximately \$10.00 per acre for material. Such spraying does not permanently injure the grasses in the pasture or meadows. *N.B.* Never use sodium chlorate any place where there is danger of fire.

(5) *Field Bindweed, Wild Chicory*—These weeds require two applications of a weed killer with a sodium chlorate base or pure sodium chlorate. Spray the bindweed first, when it is in full bloom, and again about two months later. Sodium chlorate has given slightly better results on the bindweed than the other materials tested. Spray the chicory the first time just as it commences to bloom, and the second time a month later.

(6) *Twitch Grass*—This is one of the most difficult weeds to eradicate with chemicals. Spray it three times with a weed killer with a sodium chlorate base, or with sodium chlorate. Give the first application just as the twitch grass comes into ear; the second, when two inches of new growth have appeared and the third a month later. When three applications of these weed killers have been made there will be a residual effect upon the crops the following year but this will not be noticed the second year after treatment.



Fig. 61—Unsprayed portion of field. Note the abundance of ox-eye daisy.



Fig. 62—Sprayed portion of the same field. Note the absence of ox-eye daisy.

(7) *Canada Thistle*—After a heavy frost in the fall, scatter sodium chlorate crystals at the rate of one pound per one hundred square feet on the thistles.

(8) *Field Mustard*—This weed may be prevented from seeding in cereal crops, by spraying with a 2 per cent. copper sulphate solution applied at the rate of one hundred gallons per acre. This solution is prepared by dissolving one pound of blue-stone (Copper sulphate) in each five gallons of water. Spray the field just as soon as the first few mustard plants come into flower. The grain may be slightly burned, but no permanent injury will occur. A potato sprayer can be fitted with a special broadcast attachment for spraying large areas or an orchard sprayer, equipped with a cluster of nozzles or broom, can be used effectively.

(9) *Poison Ivy*—Give one application of a weed killer with a chlorate base, at any time during the growing season. If the plants are sprayed in the early summer, some new growth may appear later in the fall. If this happens, a second application should be given. In exceptional cases, when the poison ivy plants are very old and woody, another application may be necessary the following spring. When working with poison ivy, gloves and rubber boots should be worn.

(10) *Driveways, Paths, Tennis Courts*—To keep these free of grass and weeds give a heavy application of a weed killer with a sodium chlorate base, three pounds per gallon of water, and apply in the early summer at the rate of one gallon per one hundred square feet.

(11) All weed killers should be used with great care near valuable shrubs, trees and other vegetation. These may be seriously injured if weeds near them are sprayed heavily with a weed killer.

(12) While it is claimed that sodium chlorate and weed killers with a sodium chlorate base are not poisonous, it is advisable to keep livestock away from sprayed pastures or treated areas of weeds, until such areas have received a heavy shower of rain. As a precautionary measure keep plenty of salt available to the livestock as sodium chlorate has a flavour very similar to common salt.

(13) *Chickweed*—To eliminate this weed from lawns and golf course greens, use the following home-made mixture:

Ammonium sulphate	15 pounds
Calcined iron sulphate	5 pounds
Sharp, clean, fine, sand	100 pounds

Mix well the ammonium sulphate and sand; add the calcined iron sulphate, mixing it thoroughly with the other materials.

For the best results apply this mixture to the chickweed early in the growing season, approximately May 10th. Scatter the material on the chickweed early in the morning when there is a heavy dew on the grass and when the day promises to be warm. Put on sufficient material to thoroughly cover all the leaf growth of each plant. Watch the treated areas carefully, and as soon as the leaves of the chickweed are severely burned, the whole area should be thoroughly soaked with water. Twelve to twenty-four hours is usually sufficient time to allow before watering the lawn or greens after the application is made.

It is wise to follow this treatment with an application of ammonium sulphate (one part of ammonium sulphate to three parts of sand by weight) at the rate of four pounds per thousand square feet. Immediately after this fertilizer is applied,

water the grass thoroughly in order to prevent burning. This treatment will hasten the growth of the grass and cause it to fill in the treated spots more rapidly.

(14) *Sodium Chlorate*—This is one of the cheapest and one of the most effective weed killers, but unfortunately there is a decided fire hazard in its use. It is as dangerous as gasoline and should be handled with even greater care. This fire hazard can be reduced to a minimum by taking the following precautions:

(a) Never allow the sodium chlorate to become mixed with sulphur or organic matter.

(b) Store the steel drums of the chlorate in a dry place, and when using the chlorate take the drum to the field and remove the material as it is required.

(c) Always wear rubber boots when spraying with sodium chlorate solutions and if your clothes should become damp with the spray, wash them thoroughly in cold water before they dry.

(d) Never use sodium chlorate near buildings, fences, or any place where there is the slightest danger of fire.

(e) Do not walk through treated areas or allow implements to be drawn through them until after a heavy rain, as even slight friction is liable to ignite the sprayed vegetation and cause serious damage.

(f) Remember that sodium chlorate is inflammable and under certain conditions explosive. Therefore it should be handled with the same care that explosives receive.

(15) Best results from chemical weed killers with a chlorate base, or sodium chlorate, cannot be secured by applying them with an ordinary sprinkling can. They should be applied with a sprayer that delivers the solution in the form of a fine spray under pressure. A small wheel-barrel type of sprayer, as shown in Fig. 63 is very satisfactory for spraying small patches of weeds.

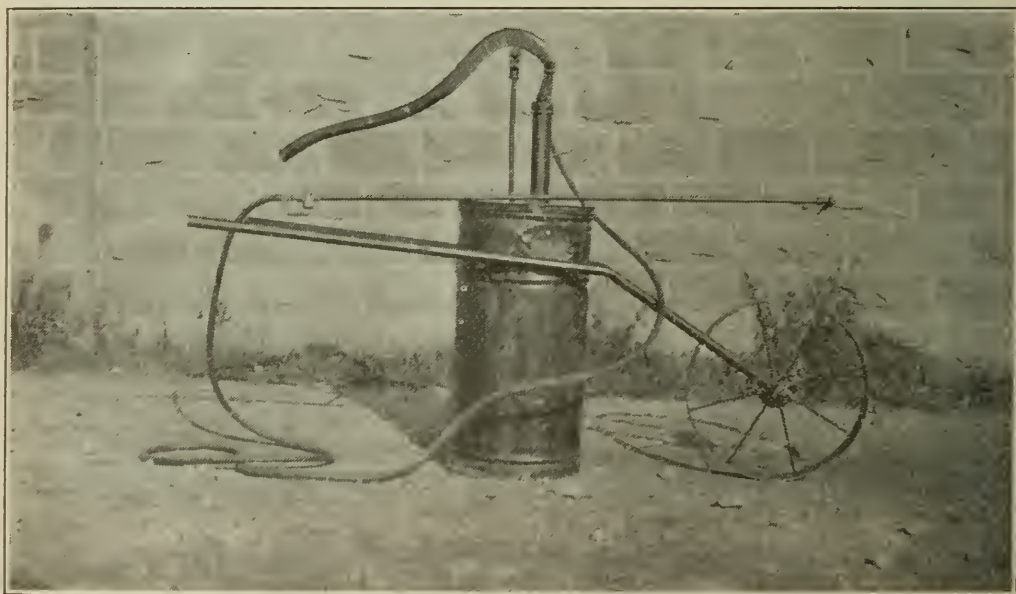


Fig. 63—A handy type of sprayer for spraying small patches of weeds.

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BULLETIN 377]

[OCTOBER, 1934

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

BEE DISEASES

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VIEW OF APIARY
ONTARIO AGRICULTURAL COLLEGE

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BEE DISEASES

INTRODUCTION

Diseases of bees are divided into two main classes, namely, brood diseases and those which attack the adult bee. Although adult bee diseases have caused great damage in sections of Europe, so far they have not been serious in any parts of North America.

The three important brood diseases of Ontario are American Foulbrood, European Foulbrood and Sacbrood. In general these diseases have quite similar characteristics. Whereas European Foulbrood and Sacbrood are easily controlled, there is no cure for American Foulbrood. To avoid serious losses it is essential that beekeepers become sufficiently informed to correctly diagnose all three diseases.

An average of about seven percent of the colonies in Ontario which are inspected are found infected with American Foulbrood and destroyed each year. This means an annual loss of between four and five thousand colonies. Besides the loss in bees, honey and equipment, many beekeepers become discouraged and sell their bees or, which is worse, neglect their colonies, leaving them as a source of infection to other people's bees. Although some parts of the Province have suffered from diseases more than others, no area is outside their range.

Due to the inspection system in Ontario, disease has been held in check and beekeeping on a commercial scale is made possible. Complete eradication, however, can never be attained until every beekeeper becomes his own inspector. It is the aim of this bulletin to place before the beekeeper in a clear and simple form the essential facts regarding identification and control of bee diseases.

EXAMINATION OF COLONIES

Control of disease is best effected by giving the colonies two thorough inspections each year. The first examination should be made in the spring at the beginning of the fruit bloom and dandelion flow before the first super is added. If disease is controlled at this time the loss of one or more supers is avoided. In addition to this the disease does not get a chance to spread to other colonies and cause trouble later on in the season when there is surplus honey in the hives. Any infection picked up by bees robbing diseased colonies during the fall and early winter is usually evident and may be brought under control before it spreads too far.

A second thorough examination is advisable during the summer just prior to the removal of the light honey crop. When the bee escapes are being placed on the hives, very little additional effort is required to examine the brood combs. Finding disease at this time allows the beekeeper to keep diseased supers away from clean equipment. Colonies having disease during the fall will likely die before spring and act as a potent source of infection to other colonies.

Detection of disease is much easier on a bright day. When examining a frame shake most of the adhering bees into the hive. By standing in such a manner that the sun shines into the base of each cell, little difficulty will be experienced in detecting abnormalities of the brood. A thorough examination in the above manner should always be given before interchanging frames of brood or honey with another colony.

It is impossible to control disease if colonies are kept in box hives. Infection cannot be detected unless combs are removable. Box hives are therefore a menace to the industry. The Foulbrood Act demands that all bees in such hives be transferred to movable frame hives.

NORMAL DEVELOPMENT OF HEALTHY BROOD

There are two types of insect development. In the case of the grasshopper for example, the egg hatches into a young insect or nymph very similar in appearance to the adult. This is called incomplete metamorphosis. The second type of development, under which the honey-bee is classed, is called complete metamorphosis. The honey-bee egg develops into a small white grub or larva. This later spins a fine cocoon and goes into the pupal or transition stage from which it emerges a fully developed bee.

In order to detect unnatural conditions of the brood the beekeeper must know the life history and the appearance of healthy brood at every stage of its development. A study of the life history chart in conjunction with Figure 1 will give the story of this development.

AVERAGE LIFE CYCLE OF THE HONEY BEE

Stage	Queen	Worker	Drone
Egg -----	3 days	3 days	3 days
Larva -----	5½ days	6 days	6½ days
Pupa -----	7½ days	12 days	14½ days
Total -----	16 days	21 days	24 days

The egg of the bee is a small, white cylindrical object about 1/10 of an inch long, somewhat larger at one end (future head end) and slightly curved. It is deposited on the base of the cell by the queen and is fastened in place by a secretion.

The larva, at first very small, grows rapidly, and in a few days occupies the whole of the base of the cell. The healthy larva before being sealed lies curled up in the base of the cell and is a glistening pearly white colour, with the segmentation of the body clearly shown. Three or four days before the larva actually transforms to the pupal stage, the cell is sealed by the nurse bees. The curled larva straightens out in the cell and spins a thin cocoon preparatory to transformation to a pupa. Figures "a" and "b" show the egg and larval stages before capping, "c" and "d" the larval and pupal stages after being sealed.

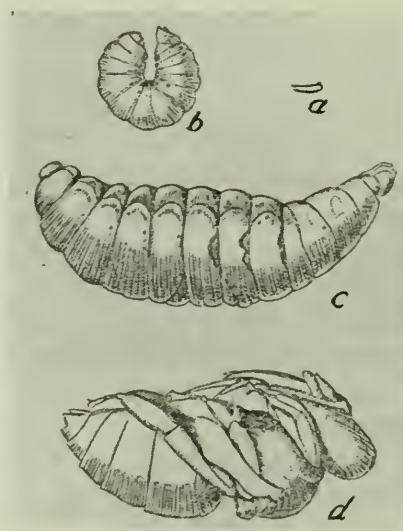


FIG. 1.

The honey bee: a, Egg; b, young larva; c, old larva; d, pupa. Three times natural size. (U.S. Dept. of Agr. Farm Bulletin 447.)

AMERICAN FOULBROOD

The term "American" is used simply to differentiate this disease from other brood diseases. It does not imply either origin or location of the disease.

(a) SYMPTOMS

Appearance of diseased comb. If disease has been present in a colony for some time the comb will assume a mottled or pepper-box appearance. This is caused by open cells containing dead larvae or scales being interspersed with normal brood. This mottled effect is also characteristic of other diseases.

Condition of cappings. Normal healthy cappings are light brown in colour, becoming slightly darker with age. They are somewhat rounded or convex in shape. If a diseased larva or pupa is present in the cell the capping frequently becomes sunken and dark brown in colour. Many cappings are perforated with one or two small holes by the bees as though they were investigating the tardy emergence of the brood.

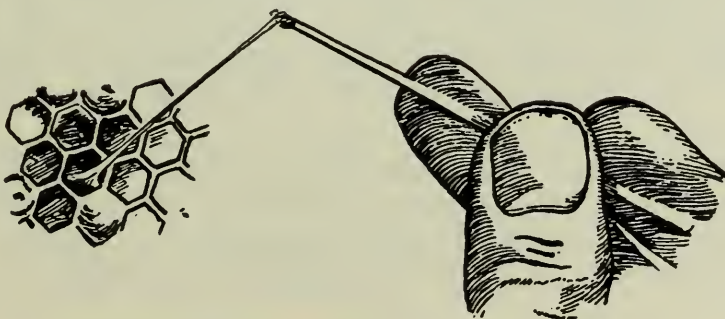
Time of death. Death occurs from American Foulbrood almost invariably two days before or two days after the transition to the pupal stage at which time the cells are capped.

Position in the cell. Larvae lie curled in the cell at the time capping takes place. After the cell is sealed the larva straightens out, lying flat along the bottom of the cell. Three to four days after capping the change to a pupa takes place. It is within two days either before or after this transformation that death occurs. Due to the uniform position in the cell at this time the decaying brood settles in a regular, uniform mass, to the bottom of the cell. This characteristic is contrasted to European Foulbrood where the decaying brood is usually twisted in the cell.

Colour changes. Healthy larvae are pearly white in colour. Decaying larvae dead of American Foulbrood are first a light yellow brown. As they settle down in the cell the colour changes gradually to a dark, coffee brown, which is of uniform shade over the entire body surface.

Appearance of affected pupae. Pupae dead of the disease go through the same process of decay and settling and similar colour changes as the larvae. The tongue of the pupa is nearly always extended towards the top wall of the cell. This is a definite sign of American Foulbrood.

Ropiness of American Foulbrood. American Foulbrood destroys the larval or pupal tissue. The body wall soon becomes soft and easily ruptured. Dead brood passes through several stages of decay, each stage varying in colour, shape and consistency. After about three weeks of decay, until the scale is formed, a characteristic ropiness is exhibited. During this period a toothpick inserted into the mass will draw out a fine gluey thread of decaying matter. (Fig. 2.)



The ropiness of American Foulbrood
(U.S. Dept. Ag., Far. Bul. 442)

Although this ropiness is a definite characteristic of American Foulbrood, it should be remembered that it only occurs at a certain stage of putrefaction. When a suspicious cell is found during inspection, all other symptoms should be carefully observed before inserting a toothpick and destroying the larva or pupa for further inspection. Too many beekeepers have the habit of inserting a toothpick immediately they see a suspicious cell.

This destroys other important symptoms.

American Foulbrood odour. In the early stages of American Foulbrood no odour is evident. In advanced stages, however, where much brood is dying and the disease has been present for weeks, the odour is quite distinct. The smell is characteristic, but is probably best described as resembling that of heated glue.

The value of odour is overlooked by many experienced beekeepers. Even when a small amount of infection is observed a diseased larva may be removed on a match or toothpick and an effort made to detect the characteristic odour. Some people have a very highly developed sense of smell and with such this point is a great help in diagnosis.

Formation of a Scale. After four to five weeks the decaying brood dries down to a hard dark scale. American Foulbrood scales are characteristically uniform in shape, covering the greater portion of the lower cell wall and extending part way up the back wall. The scale adheres tightly to the cell and cannot usually be removed without tearing the cell wall.

(b) CAUSE OF AMERICAN FOULBROOD

In 1902 Dr. G. F. White, United States Department of Agriculture, first demonstrated that the disease was caused by a bacteria which he named *Bacillus larvae*. Certain bacteria have the ability to form a protective covering around themselves. In this stage, called spores, they are capable of existing for long periods away from their host. *Bacillus larvae* is a spore forming bacteria. It will live for years in honey and will often withstand boiling in water for twenty minutes. This spore forming characteristic makes *B. larvae* very difficult to exterminate.

(c) METHOD OF INFECTION

Spores of American Foulbrood become dispersed through the honey of diseased colonies from scales present in the cells. Larvae fed with this diseased honey become infected and death occurs a few days later.

(d) METHODS OF SPREAD

American Foulbrood is spread chiefly by robbing infected honey from diseased colonies, either dead or alive. Great care should be taken to see that dead or weak colonies are not robbed out in the spring. The entrances of these colonies should be closed or the hives removed to a bee-tight dwelling about the first of April. This precaution is extremely important. It is possible for one diseased colony to infect a whole apiary. Infection may also be carried from one hive to another by drifting of the nurse bees, especially during manipulation of the colony. Great care should be taken in interchanging combs from one hive to another.

Bee trees are often given too much credit for the spread of disease. Although colonies in trees may spread American Foulbrood, stray swarms which become weakened and die from disease do not long remain a menace. They are soon cleaned up by wax moths, ants and other insects or animals.

(e) IMMUNITY TO AMERICAN FOULBROOD

Although workers are most commonly infected, drones and queens are also

susceptible to the disease. From the results of experimental inoculations and beekeepers' experience it appears that no race of bees possesses any marked immunity to the disease.

(f) ERADICATION OF AMERICAN FOULBROOD

The old shaking treatment, whereby the bees of a diseased colony are shaken on to foundation and thus saved can no longer be advocated. Although successful occasionally when performed by an expert beekeeper, it has been found that the treatment in general tends to spread disease rather than eradicate it. When combs are shaken there is a tendency for young nurse bees, not having marked their location, to fly into nearby hives carrying diseased honey with them. Another criticism of the treating system aside from general spread of disease at the time of treatment is that diseased combs are often stored for some time before being rendered. This is very dangerous as there is always a grave danger of infection by bees robbing stored combs. The treating plan proved to be false economy. It is cheaper to kill diseased bees and make increase from healthy colonies.

Burning diseased colonies. The only known method at present by which American Foulbrood may be completely stamped out is by burning the bees and combs and sterilizing other parts of the hive by fire. Disease has been entirely cleaned up in restricted areas by this plan and there is every reason to believe it could be completely eradicated from the Province. Immediately the disease is found it should be destroyed. Delay is generally costly.

Considerable work has been done in an effort to find some drug or chemical that would effectively cure a colony of American Foulbrood. So far there has been no success along this line.

STEPS IN ERADICATING AMERICAN FOULBROOD

1. Inspect the colonies giving each frame a thorough examination. If disease is found, mark the colonies carefully so there will be no possible danger of overlooking them later.

2. Dig a hole in the ground large enough to accommodate all the combs. Unless the hole is large diseased honey will be spilled around the surface of the soil and spread disease. Do not dig the hole too near a tree or the fire will wilt the leaves and injure the tree. Allow for the wind and be sure the fire is situated where there is no danger of spreading. Place some rough chunks of wood in the hole to ensure a good draft and sufficient fuel to thoroughly consume all diseased material.

3. Kill the bees. In the past gasoline was used for this purpose but it is not as satisfactory as cyanogas, which is a commercial preparation of cyanide in powder form. When gasoline is used the bees fly from the hive unless the entrance is closed. Cyanogas kills the bees without their realizing any danger. Field bees will also fly into the hive. When using cyanogas sprinkle a dessert-spoonful on top of the frames and a little in the entrance to catch the incoming bees. Five minutes is long enough to leave the colony after adding the cyanogas, otherwise many of the bees recover as the powder becomes spent and the gas drifts from the hive. Great care should be taken when using this poison as a few good breaths might easily prove fatal. There is no necessity to wait until evening to kill colonies.

4. Light the fire. It is advisable to use coal oil and get a good strong flame so the diseased material may be disposed of as quickly as possible.

5. Carry the hives complete to the fire and throw on the combs. Be sure no dead bees drop from the entrance as most of them exude a drop of honey

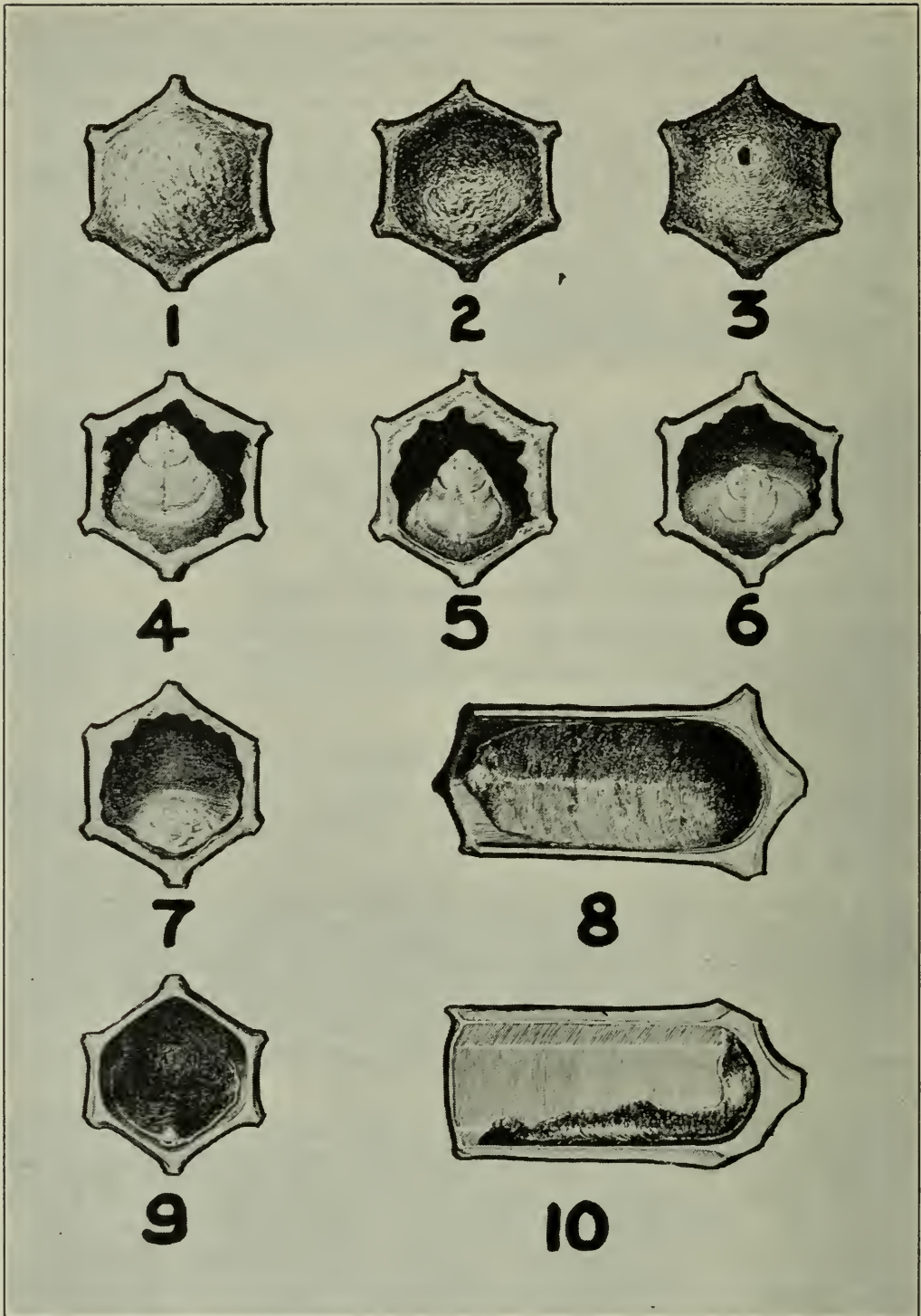


PLATE 1.

American Foulbrood, death occurring in the larval stage:
 1. Healthy capped cell; 2, 3. Capped cells containing dead
 larvae; 4. Healthy larva; 5, 6, 7, 8. Progressive decay; 9, 10.
 dry scales.—(*Reproduced from U.S.D.A. Bulletin 809.*)

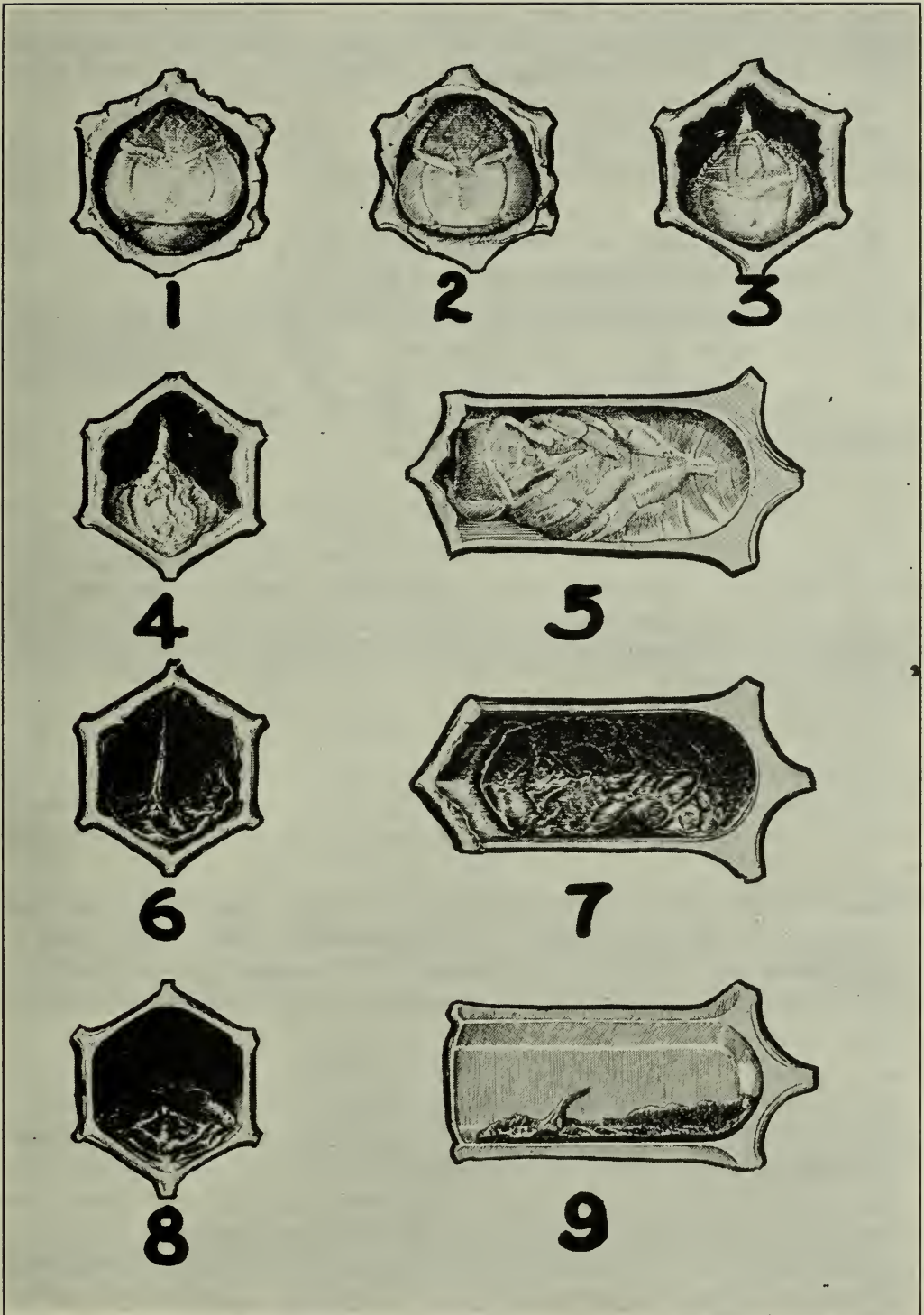


PLATE 2.

American Foulbrood, death occurring in the pupal stage:
 1. Healthy pupa; 2, 3, 4, 5, 6, 7. Progressive decay of dead
 pupae; 8, 9. Dry scales.—(*Reproduced from U.S.D.A. Bul-*
letin 809.)

which sticks to their tongues and may be diseased. If the combs are heavy with honey keep the fire well bolstered up with chunks of wood.

6. Scrape thoroughly and disinfect by scorching all boxes, bottom boards and covers. Covers and bottom boards may be sterilized by holding them over the fire for a few seconds, on a fork or long stick. Boxes may also be treated in this manner or else piled one on top of the other sprinkled inside with coal oil or gasoline and ignited. The flame may be extinguished by placing a cover on the top box, thus excluding the air.

7. All dead bees and other debris that might carry infection should be scraped into the fire. When everything has burned down to an ash, fill the hole in thoroughly.

8. Hive tools should be disinfected with fire and the hands washed with soap and water before examining other colonies.

Chemical treatments for diseased super combs which were once recommended have proved unsatisfactory. If a beekeeper is suspicious of his super combs the best practice is render them into wax and have it made into foundation. The actual cost of this procedure is not great and it is considered sound economy by many successful beekeepers.

EUROPEAN FOULBROOD

Less than forty years ago this disease caused the beekeeping industry considerable anxiety. It spread with remarkable rapidity, wiping out whole apiaries. Today beekeepers have learned that it can be easily controlled by keeping the colonies strong and using resistant Italian stock. It is no longer a menace to the industry.

(a) SYMPTOMS

The appearance of larvae dead of European Foulbrood varies considerably and the symptoms are more variable than those of American Foulbrood. Always keep in mind the appearance of healthy brood when inspecting for indications of disease.

Appearance of comb. The presence of many uncapped cells, containing diseased larvae in the early stage of development, gives the comb a spotted irregular appearance. Should the majority of larvae die at a later stage of development after the cells are sealed, the cappings are sunken, perforated and decidedly greasy in appearance.

Time of death. All larvae die before the transformation to the pupal period. About ninety percent die one or two days before the cell is capped. Probably ten percent die the first or second day after capping, i.e. when the larva is beginning to straighten out in the cell preparatory to its transformation to the pupa. Occasionally an outbreak of European Foulbrood takes place where colony after colony contains larvae most of which are attacked at this later stage. This type is often confused with American Foulbrood. The variability displayed in time of death makes diagnosis more difficult. In typical European Foulbrood, however, the cell is uncapped.

Position in the cell. Larvae exhibit marked variation in their position according to the age at which they die. Young larvae dying at the characteristic stage while still curled generally squirm around as though in pain assuming unnatural positions in the cell. Those larvae that die after capping are larger and lie more uniformly extended in the cell.

Colour changes. The pearly white colour of healthy larvae changes to greyish yellow. As putrefaction continues the colour deepens to a dark greyish brown mass.

Consistency of dead larva. After approximately three weeks of decay the larva becomes a sticky, somewhat granular mass. The granular appearance at this stage is contrasted to the smooth glue-like appearance of American Foulbrood.

Tracheae visible. The tracheae are glistening, silvery air tubes situated below the skin. In many larvae dead of the disease these tracheae may be plainly seen and remain visible during the complete process of putrefaction. The presence of tracheae is an important symptom to differentiate infection in the advanced larval stage from American Foulbrood.

European Foulbrood odour. In advanced cases, especially where many larvae die in the capped over stage, there is a very offensive odour. It is described as resembling that of rotten fish.

Scale formation. The dried larval remains are less brittle and more rubber-like than American Foulbrood scales. They are shrivelled, brown in colour and can easily be removed from the cells. The fact that brood dead of European Foulbrood can be removed by the bees makes it possible for strong colonies to clean up the disease.

(b) CAUSE OF EUROPEAN FOULBROOD

Bacillus pluton, a non spore former, is considered to be the organism which actually causes the death of the larva. Invariably, however, there are secondary organisms present, the chief of which is *Bacillus alvei*. When a laboratory diagnosis is made the presence of *Bacillus alvei* indicates European Foulbrood.

(c) METHODS OF SPREAD

The organism causing European Foulbrood doesn't form spores so is unable to live over winter in honey. It is carried over in pieces of dead larvae. From this small beginning in the spring it can spread very rapidly under favourable conditions. If nectar is stored in contaminated cells and fed to larvae they contract the disease. Further spread may be caused by robbing, interchanging combs or drifting nurse bees.

(d) IMMUNITY TO EUROPEAN FOULBROOD

Workers, drones and queens are all susceptible to European Foulbrood. Italian bees, due to their vigorous house cleaning habits, stop the spread of disease and eventually eradicate it. Some strains are far more efficient in cleaning out dead larvae than others. Black bees are very susceptible to the disease.

(e) ERADICATION

European Foulbrood has not caused very serious trouble since beekeepers have learned the present preventive measures. Most definite progress in its control has been made through Italianizing all colonies and breeding queens from resistant stock.

It must be remembered that European Foulbrood is a disease of weak colonies. The introduction of an Italian queen to a very weak colony is useless if European Foulbrood is present. Weak colonies should be united to stronger ones before requeening. If resistant Italian queens are used and the best methods of beekeeping, which ensure strong colonies, are followed there will be little trouble with European Foulbrood. A colony at the beginning of the honey flow should be strong enough to have eight full combs of Langstroth size filled with brood.

Proper wintering of bees is a matter of highest importance in regions where European Foulbrood is found. As very little infection is carried over the winter the first brood of the year usually escapes with little loss. For this reason it is essential to have as much brood as possible get away to a good start early in the

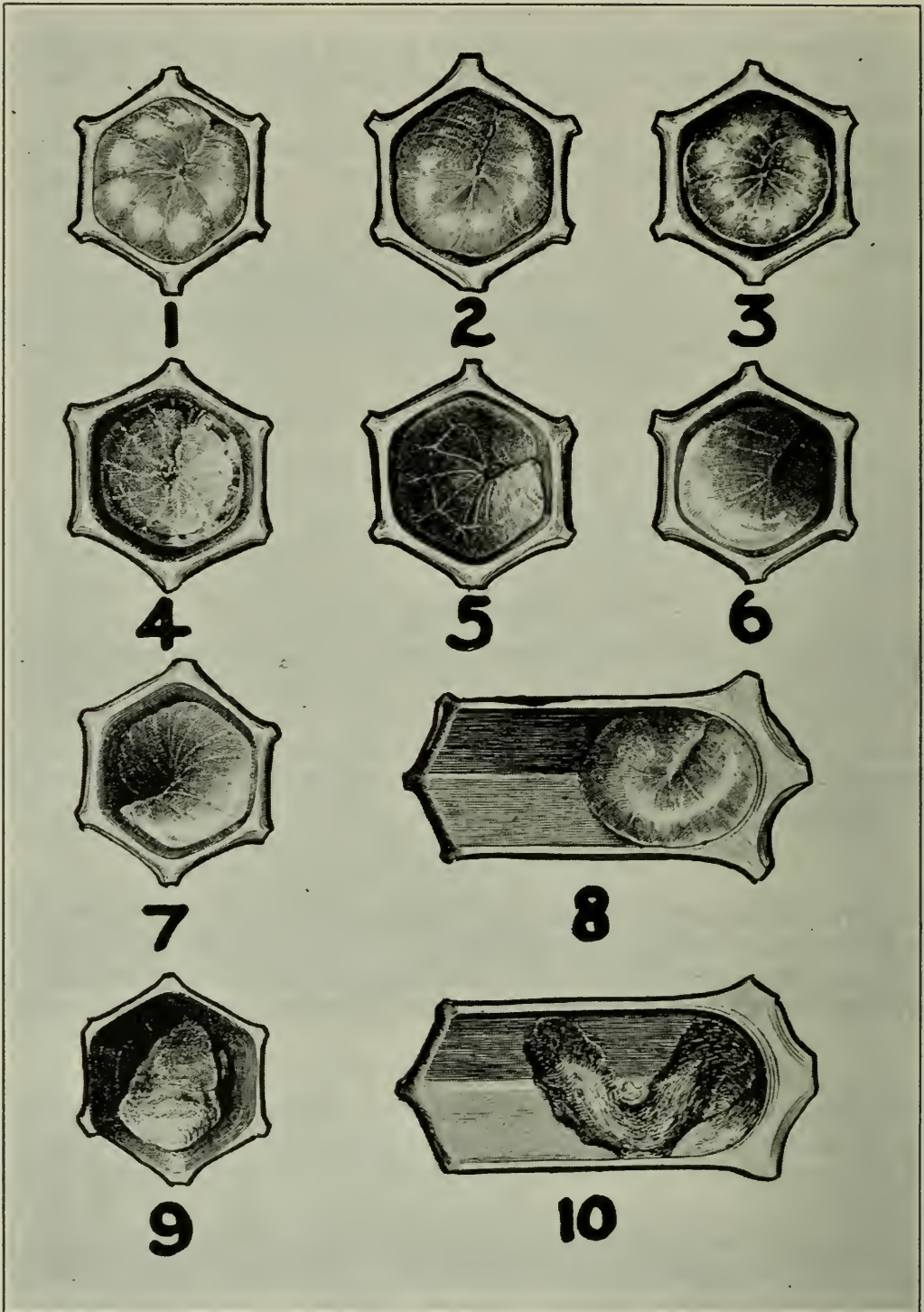


PLATE 3.

Characteristic European Foulbrood, death occurring in the early larval stage: 1. Healthy curled larva; 2 to 10. Various stages of decay; 4, 5. Shows tracheae; 6, 7. Larva twisted in cell; 9, 10. Dried out scale.

—(Reproduced from U.S.D.A. Bulletin 810.)

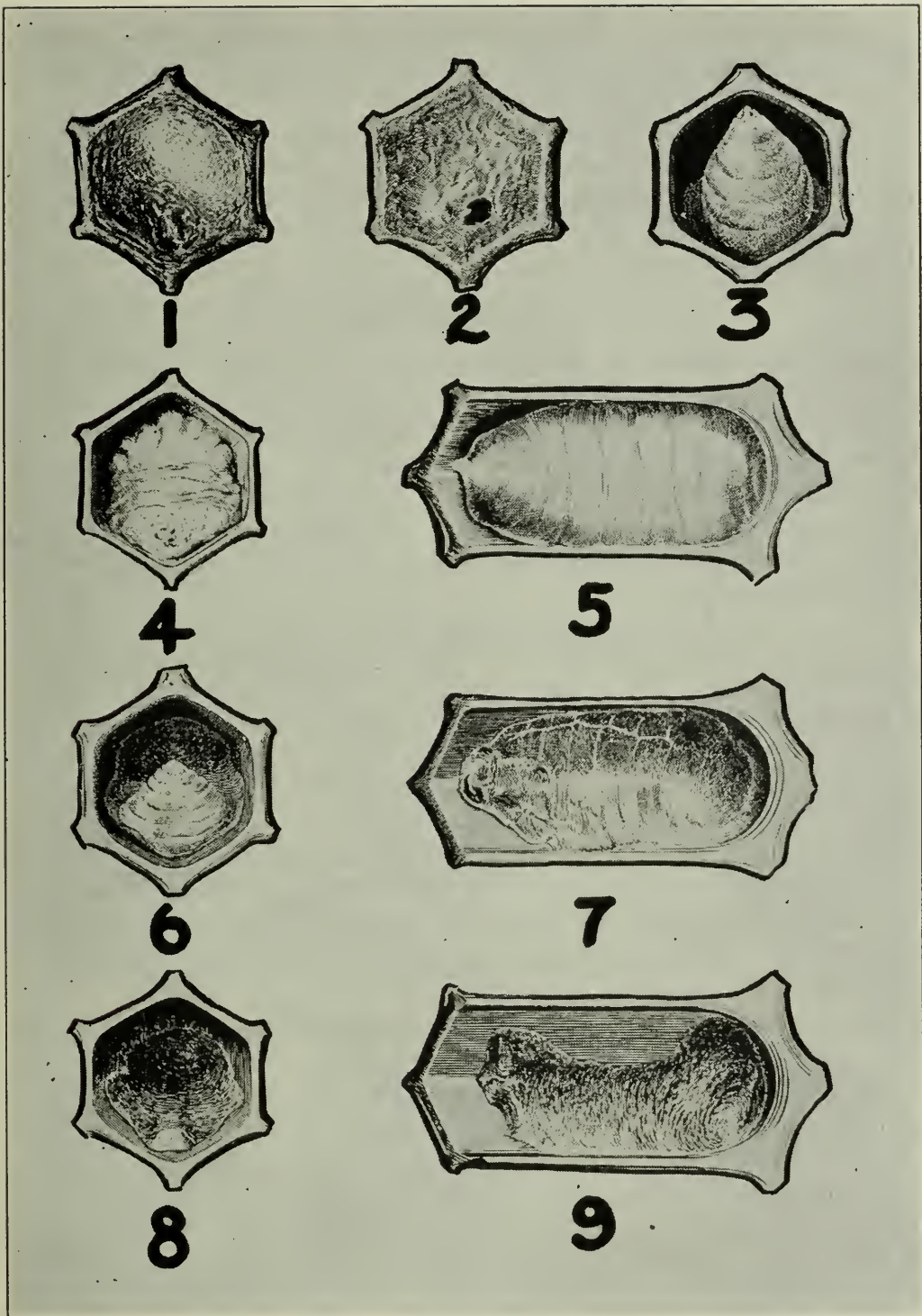


PLATE 4.

European Foulbrood, death occurring in the late larval stage:
 1, 2. Capped cells containing larvae dead of European Foulbrood;
 4. Dead larva showing part removed by the bees; 3,
 5, 6, 7. Various stages of decay; 8, 9. Dried out scales.

—(Reproduced from U.S.D.A. Bulletin 810.)

spring. The emerging bees are then able to ward off the disease throughout the season.

Where the disease has become well established, it is sometimes difficult for the bees to make any headway in cleaning it up. Removal of the queen for a few days causes a period in which no brood is being fed. This give the bees a chance to make more rapid progress. As soon as the dead larvae are removed, the queen is returned or better still the colony is given a young Italian queen.

How the disease spreads is not thoroughly understood. Honey has a definite devitalizing effect upon the organism so is not a serious carrier. It is never necessary to destroy or disinfect combs, brood, or honey from European Foulbrood colonies. Normally requeening and strengthening the colony will satisfactorily control the disease.

SACBROOD

Sacbrood is an infectious disease of the brood of bees. Although it is not particularly malignant and rarely, if ever, causes the death of a colony, it is responsible for the loss of much brood. Where the disease is advanced the death of many worker larvae results in the weakening of the colony. Brood rearing space may also be considerably reduced by the presence of dead larvae in the cells.

The disease has never proven very serious in Ontario but it is essential that beekeepers be able to differentiate between it and other brood diseases, especially American Foulbrood.

(a) SYMPTOMS OF SACBROOD

Character of comb and cappings. As in other brood diseases the presence of affected brood, interspersed with healthy brood, gives an irregular appearance to the comb. Larvae die after the cells are capped. A considerable proportion of the cappings are uncapped by the bees. As a rule the proportion of brood affected is not large.

Time of death. Affected larvae die after the cells are capped but before the change to the pupal stage is completed. The majority die during the two day prepupal period, i.e. within the two days preceding the transformation. Many uncapped cells are generally observed on diseased combs but they are uncapped by the bees after the death of the larvae.

Position in the cell. Dead larvae are extended lengthwise along the floor of the cell. The position is similar to that of larvae affected with American Foulbrood. Sacbrood, however, can be determined by the appearance of the head which is dark, somewhat shrivelled and turns up towards the roof of the cell.

Colour changes. Soon after death the larval remains are slightly greyish white in colour. This greyish colour turns to a greyish brown tint which deepens as the process of decay continues. Throughout this period of decay the head end appears somewhat shrunken and much darker than the more posterior, or hind, portion of the body.

Consistency of dead larva. The body wall of a larva dead of Sacbrood becomes toughened and may be easily removed intact from the cell. When removed from the cell the larva is sac-like in appearance. The contents of the sac are watery, containing many fine brown granules.

Odour. Sacbrood has no distinctive odour.

Scale formation. Scales formed from sacbrood are greyish black, roughened and generally curl up at the anterior or head end. Scales are not common as the bees generally remove the dead larvae before the scale is formed. When present they are loose in the cell.

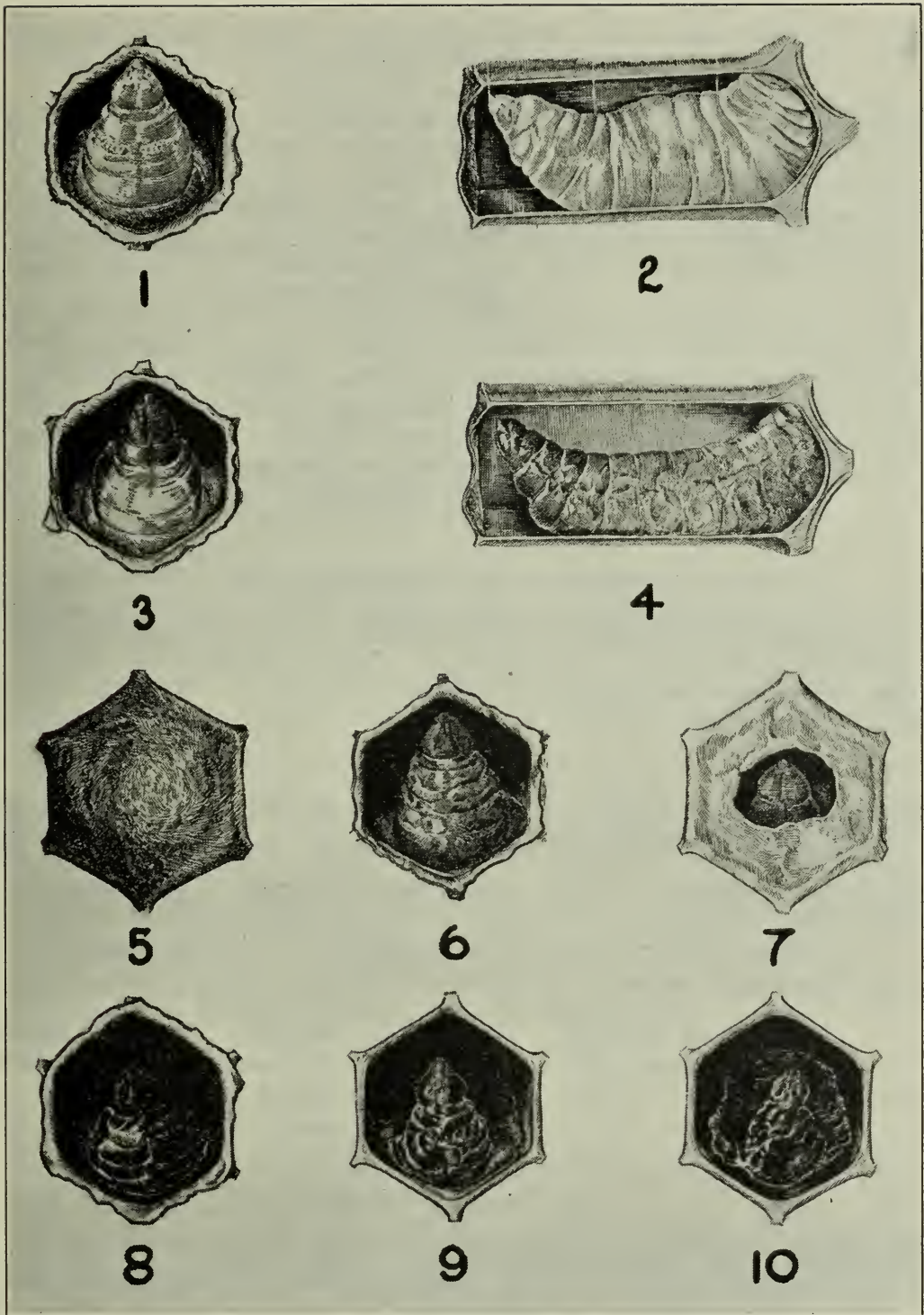


PLATE 5.

Sacbrood: 1, 2. Healthy brood at the age at which it dies of Sacbrood; 3, 4. Brood recently dead of disease; 5, 6, 7, 8, 9, 10. Brood in various stages of decay.

—(Reproduced from U.S.D.A. Bulletin 431.)

COMPARISON OF BROOD DISEASES

	A. F. B.	E. F. B.	SACBROOD
Cappings	Many sunken, dark and perforated.	Usually none. When larvae in advanced stages of development, capping, sunken, perforated and greasy.	Many uncapped; some perforated.
Time of Death	During prepupal stage or within two days after transformation to pupa.	Before change to pupa. Generally quite early and before capping. Advanced larval stages often capped.	Before change to pupa. after capping.
Position in the Cell	Straightened out, regular and uniform. Occupies most of lower cell wall. Posterior, or hind end, extending up back wall of cell.	90% of cases curled in the cell and in unnatural positions. 10% in advanced larval stages fairly regular and extended in the cells.	Uniform shape and position in cell with head end curled up.
Colour Changes	From light yellow-brown to dark coffee-brown. Uniform throughout.	From greyish-yellow to dark greyish brown. Not uniform.	From a light yellowish grey to dark brown. Rather uniform.
Appearance of Pupa	Same process of decay as larva, tongue extended upwards.	None die.	None die.
Consistency	Soft mass. Exhibits ropiness at certain stage.	Somewhat sticky and granular.	Body wall tough, contents watery.
Tracheae	Not visible.	Often plainly visible.	Not visible.
Odour	Odour of heated glue in advanced stages.	Fishy odour in advanced stages.	No odour.
Scale	Hard, dark, uniform scale. Adheres tightly to cell.	Rubber-like, irregular, shrivelled, dark brown scale. Easily removed.	Black, roughened curled up at anterior or head end.

(b) CAUSE OF SACBROOD

No organism has been found present in dead larvae which can be demonstrated to cause the disease. It has therefore been concluded that the disease is caused by a virus which will pass through the finest of filters. A colony may be inoculated with the disease by feeding syrup of honey containing the virus from dead larvae.

(c) SPREAD OF SACBROOD

Sacbrood virus is readily destroyed. Larvae dead of Sacbrood cease to be infectious after one month. How the disease winters over is not known. Colonies infected in the spring generally recover during the honey flow. The weakening effect of the disease during the spring stays with the colony throughout the honey flow.

(d) CONTROL MEASURES

Vigorous colonies rarely suffer to any extent from Sacbrood. Requeening and strengthening will generally clean up any infection that may occur. It is never necessary to destroy any part of a hive infected with Sacbrood.

FUNGIOUS DISEASES

Fungous diseases, although never particularly serious, cause considerable damage in the aggregate loss of bees. There are many types of fungi affecting bees both as brood and adults. Conditions such as the so-called stone brood and chalk brood are typical of the work of fungi. The dead remains become dry and mummified. Molded combs and equipment and mouldy fruits, etc., are believed to cause the infection.

Other abnormal brood conditions. Brood is frequently found dead in a colony from causes other than infectious disease. We find chilled brood, starved brood and overheated brood. Generally the appearances are characteristic but at times the symptoms may be quite similar to one of the brood diseases. If in doubt a sample of comb or smear consisting of the contents of one or more cells folded in a piece of waxed paper, should be sent to the Apiculture Department, Ontario Agricultural College, for examination.

DISEASES OF ADULT BEES

To date there has been no serious trouble from adult bee diseases in any part of Canada or the United States. In England and other parts of Europe they have caused great loss. It is necessary that we know something of the symptoms of these diseases and be ready to stamp out any infestation that might occur.

(a) ISLE OF WIGHT DISEASE

This disease has been a very serious source of loss to British beekeepers. It is caused by a minute mite which crawls into the bee's spiracles choking off its supply of air and possibly secreting a toxine which paralyzes the wing or flight muscles. Most adult bee diseases have quite similar symptoms, making diagnosis from external characteristics difficult.

The following is taken from leaflet No. 253, issued by the Board of Agriculture and Fisheries, 4 Whitehall Place, London, England:

Symptoms:

1. The first symptom noticed is a disinclination to work. They fly about aimlessly and do not gather stores.
2. Later they lose their powers of flight and are unable to travel more than a few yards without alighting.
3. As the disease progresses, the bees are unable to fly more than a few feet, when they drop and crawl. They may be seen crawling up grass stems or other upright objects, but they soon fall down and die. Towards night some may be seen gathered in groups, but they usually die before morning.
4. The abdomen is often swollen.
5. The wings often appear disconnected. Sometimes the legs seem affected, and the bees stagger in their attempt to walk.
6. Finally the whole colony of workers is found clustered in front of the hive, except a few which are found crowded around the queen.
7. The queen and the brood are not attacked, though "chilled brood" often appears subsequently, owing to there being insufficient bees to keep the hive warm.

If a beekeeper notices colonies showing these symptoms, he should send some of the bees to the Apiculture Department at Guelph.

(b) NOSEMA DISEASE

This disease although fairly widespread is mild in character. It is caused by a protozoan or one celled parasite, *Nosema apis*, which infests the alimentary canal of adult bees. Bees can be infested with *Nosema* spores without showing any marked symptoms of disease, and apparently with little effect on their ability to carry on. Death may result from infection and in the case of excessive infection bring about a weakening effect on the colony through the shortening of the life of the individuals. Requeening and strengthening by giving additional capped brood usually brings relief.

(c) DYSENTERY

Dysentery is more properly a disorder than a disease of adult bees. Bees are only able to void faeces while in flight. During the winter waste matter accumulates in the lower intestine. If the food is of good quality and the bees are not confined to the hives for too long a period, they will be healthy in the spring. If the food contains considerable indigestible material and the bees are unable to fly they often die in great numbers. In cases of advanced dysentery faeces are voided within the hive and the disorder becomes evident by the resultant spotting.

Material reduction in the adult population is a serious handicap during the spring building-up period. Dysentery can be prevented to a great extent by proper precautionary measures. Bees wintered on good honey or sugar syrup are rarely affected. Poor food, such as honey-dew honey, nearly always produces the disorder. Proper winter protection and freedom from disturbances during winter are also factors in the control of dysentery.

(d) PARALYSIS

Very little is known about bee paralysis. It is possible that there are several conditions which result in the so-called paralysis. At any rate beekeepers frequently report that they have observed worker bees crawling in front of the hive with their abdomens trembling. They keep crawling up the side of the hive and up blades of grass and tumbling to the ground. Occasionally individual colonies become rapidly depleted in bees. There is a possibility that the disease may be caused by certain foods.

(e) SPRING DWINDLING

Spring dwindling is the term used to describe the condition when adult bees in a colony die off more rapidly than they are replaced by emerging brood. The condition is brought about by poor wintering and by the colony going into winter with too large a percentage of old, worn-out bees. To prevent this colonies should be supplied with vigorous queens that will continue brood rearing as late as possible in the fall.

PESTS OF THE APIARY

(a) GREATER BEE MOTH OR WAX MOTH

This is a pest of weak colonies and of stored combs. It is much more prevalent in some localities than others. The adult moths fly almost entirely at night. The eggs may be laid between the supers or within the hive. The tiny larvae emerge within a few days and being extremely active soon disperse

throughout the hive. They usually burrow along the mid rib of the comb, out of reach of the bees, spinning a tough cocoon as they travel. The larvae feed on a combination of wax and pollen. If no pollen is available, as in the case of comb honey infestations, the larvae are unable to develop into the adult stage.

Combs left exposed act as breeding places for this troublesome pest and beekeepers should be careful to keep all combs out of reach of the moth.

When weak colonies are attacked the beekeeper should remove as many of the bee moth larvae as possible as well as the webbing and cocoons. The colony should then be united with a strong colony or strengthened by adding more bees. Italian bees are more resistant than black bees. Strong colonies are rarely infested.

Stored combs not too badly damaged may be saved from further injury by fumigating them with cyanogas, carbon bisulphide or sulphur. In districts where the wax moth causes a great deal of trouble it is advisable to fumigate the super combs every winter. If the combs are stored in a cold place, however, where the temperature goes down to zero all larvae and pupae will be killed.

Cyanogas is convenient and quite satisfactory for the treatment of wax moth. When using it great care should be taken that the fumes are not inhaled.

This fact cannot be emphasized too much as carelessness might easily prove fatal, but with ordinary care there is no need for an accident. When using cyanogas the supers are placed in piles about six high. One teaspoonful of the powder is all that is needed for a pile of six supers. The cyanogas is placed on a piece of cardboard on the top super. An empty box with a cover is placed on top. The gas will penetrate the combs, killing the larvae. As the eggs are not killed another teaspoonful of gas should be added about one month later.

Carbon bisulphide is used in a manner quite similar to cyanogas. It is very inflammable liquid so should be handled with care. The supers are piled up the same as for cyanogas and the liquid put in a flat dish, on the top super. An empty box with a cover is placed on top to enclose the gas which results from the evaporation of the carbon bisulphide. At low temperatures this evaporation is very slow so it is necessary to have the room fairly warm. The amount of carbon bisulphide recommended is two ounces to a pile of six supers. An equal amount should be added one month later to kill the larvae which have hatched from eggs since the first treatment.

Sulphur may also be used effectively to kill wax moth larvae and pupae in stored combs. When treating with sulphur it is advisable to space the frames and cross the supers so as to admit the maximum amount of gas to the combs. Four pounds of flowers of sulphur to one thousand cubic feet is the amount recommended. The sulphur should be burned in a metal dish supported in a larger container filled with water. A satisfactory method of igniting the sulphur is to place some live coals or burning charcoal in the bottom of the metal dish and place the sulphur on top. Another method is to add one pint of alcohol for every four pounds of sulphur and ignite. The burning sulphur unites with the oxygen of the air to form sulphur dioxide, a very poisonous gas. This treatment should also be repeated one month later.

(b) LESSER BEE MOTH

This moth is primarily a pest of stored combs and stored honey. It does most damage on the cappings and can be controlled by fumigation in the same manner as the Greater Bee Moth.

(c) THE BLIND LOUSE (*Braula coeca*)

This is a tiny reddish brown louse, which lives on the body of the honey bee. It is also responsible for considerable damage to comb honey cappings during the

larval stage. It is very prevalent in South Africa and in Europe. No extensive infestations have been reported in Canada or the United States. The louse is described as a commensal, i.e. it feeds with the bee rather than on it. When hungry the louse sucks nourishment from the bee's mouth parts. It is a source of constant irritation to the bee.

(d) ANTS

Several types of ants are common to the bee-yard. Their chief injury is in being a nuisance although they do steal some honey. They are frequently found on the quilts and should be crushed and killed whenever found.

(e) MICE

These rodents do their chief damage during the winter. They will break down comb alongside the winter cluster and build nests. Besides destroying the combs they disturb the cluster throughout the winter. They also do considerable damage to stored combs. Winter entrances should be constructed small enough that mice cannot enter and piles of supers in storage should be protected both above and below with queen excluders or bee escapes to keep mice from entering.

(f) OTHER PESTS

Skunks may considerably weaken a hive by disturbing the bees and eating them as they fly out of the entrance to protect the hive. In some localities certain birds will destroy bees by swooping past the entrances and eating the bees. The Kingbird, in Canada, does a certain amount of damage in this manner.

PRECAUTIONS

- (1) Never buy colonies of bees unless examined and guaranteed free from American and European Foulbrood by an authorized inspector.
- (2) If drawn combs, irrespective of age, are purchased with used apiary supplies, they should be rendered into beeswax, unless positive no American Foulbrood existed in the apiary from which they came.
- (3) Be sure to prevent spring robbing by closing the entrances of all dead colonies early in April, thereby avoiding the spread of disease. The entrances to weak colonies should also be reduced.
- (4) Combs should not be interchanged from one colony to another where there is danger of foulbrood being present.
- (5) Destroy all colonies having American Foulbrood immediately they are found. Make sure your diagnosis is correct before proceeding with the destruction.
If in doubt remove the contents of one or more cells and fold in a piece of waxed or hard finished paper. Place this, with your name and address, in an envelope and forward to the Apiculture Department, Ontario Agricultural College, Guelph, for diagnosis.
- (6) Since honey is one means of transmitting American Foulbrood, it should not be fed to bees unless it is known to be free from Foulbrood spores. When in doubt feed sugar syrup.
- (7) When locating an apiary don't crowd any other beekeeper. Never keep bees in box hives. The control of American Foulbrood is the beekeeper's most important problem. In order to remain in the business and ensure success, constant vigilance must be maintained.

THE BEE DISEASE ACT

Bees are of greater value to the country as pollinators, especially on fruit trees, than they are as honey gatherers. Understanding their great economic value the Foul Brood Act has been drawn up. Its purpose is to combat disease and protect the careful beekeeper.

No. 143

1931

BILL

An Act to amend The Bees Act.

HIS MAJESTY, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:

1. This Act may be cited as *The Bees Act, 1931*. Short title.
2. Subsection 2 of section 3 of *The Bees Act* is repealed and the following substituted therefor: Rev. Stat.
c. 314, s. 9,
subs. 2,
repealed.
 - (2) If the inspector finds that foul brood exists in a virulent or malignant type he may immediately destroy by fire all colonies of bees so affected, together with the hives occupied by them and the contents of such hives and all tainted appurtenances that cannot be disinfected. Destruction
where
disease
malignant.
3. Subsection 1 of section 5 of *The Bees Act* is amended by striking out the word "certificate" in the fourth line and inserting in lieu thereof the word "permit," so that the subsection will now read as follows: Rev. Stat.
c. 314, s. 12,
subs. 1,
amended.
 - (1) The owner or possessor of an apiary shall not sell, barter, give away or remove from the premises any bees or used apiary appliances or apparatus until he has secured a permit from the Provincial Apiarist that such bees, used apiary appliances or apparatus have been properly disinfected and are free from disease. Sale of
infected
bees or
articles.
4. Section 6 of *The Bees Act* is amended by striking out the words "being authorized by the Inspector" in the fourth line and inserting in lieu thereof the words "receiving a permit from the Provincial Apiarist," so that the section will now read as follows: Rev. Stat.
c. 314, s. 13,
amended.
6. Any person whose bees have been destroyed or treated for foul brood who sells or offers for sale any bees, hives or appurtenances of any kind after such destruction or treatment and before receiving a permit from the Provincial Apiarist so to do, or who exposes in his bee-yard, or elsewhere, any infected comb honey or other infected thing, or conceals the fact that such disease exists Selling
infected
bees after
treatment or
exposing
appliances.

among his bees, shall incur a penalty of not less than \$20 or more than \$50, or he may be imprisoned for a term not exceeding two months.

Rev. Stat.
c. 314, s. 15,
repealed.

5. Section 8 of *The Bees Act* is repealed and the following substituted therefor:

Employment
of special
constables
where
owner offers
resistance.

8. Where such owner or possessor of bees offers resistance to or obstructs the inspector, a justice of the peace may, upon the complaint of the inspector, cause a sufficient number of special constables to be sworn in who shall, under the directions of the inspector, proceed to the premises of such owner or possessor and assist the inspector to seize all the diseased colonies and infected appurtenances and burn them forthwith, and if necessary the inspector or constables may arrest the owner or possessor and bring him before a justice of the peace to be dealt with according to the provisions of the next preceding section.

Commence-
ment of Act.

6. This Act shall come into force on the day upon which it receives the Royal Assent.

An Act for the Prevention of Diseases Among Bees

(INCLUDING AMENDMENTS WHICH CAME INTO FORCE ON MARCH 31, 1931)

1. This Act may be known as *The Bees Act, 1931*.
- 2.—(1) The Lieutenant-Governor in Council, upon the recommendation of the Minister of Agriculture, may from time to time appoint one or more Inspectors of Apiaries to enforce this Act.
- (2) The Inspector shall, if so required, produce the certificate of his appointment on entering upon any premises in the discharge of his duties.
- (3) The remuneration to be paid to an Inspector under this Act shall be determined by order of the Lieutenant-Governor in Council, and shall be payable out of any sum appropriated by the Legislature for the enforcement of this Act.
- 2a.—(1) Every person keeping bees in the Province of Ontario shall on or before the 30th day of April in every year apply to the Minister of Agriculture in writing, signed by the applicant, for a certificate of registration.
- (2) The applicant shall be in such form as may be prescribed by the regulations and shall be accompanied by the prescribed fee for registration.
- (3) Every application shall be addressed to the Provincial Apiarist, Ontario Agricultural College, Guelph.
- (4) Where a person commences keeping bees after the 30th day of April in any year, he shall apply for a certificate of registration as hereinbefore provided within ten days after coming into possession of the bees.
- (5) Every person keeping bees who neglects or refuses to comply with the provisions of this section shall incur a penalty of not less than \$5 nor more than \$10 and costs.
- 3.—(1) The Inspector shall, whenever so directed by the Minister, visit any locality in Ontario and examine any apiary to which the Minister directs him, for the purpose of ascertaining if any infectious or contagious disease of bees exists in such apiary.
- (2) If the Inspector finds that foul brood exists in a virulent or malignant type he may immediately destroy by fire all colonies of bees so affected, together with the hives occupied by them and the contents of such hives and all tainted appurtenances that cannot be disinfected.
- (3) Where the Inspector, who shall be the sole judge thereof, finds that an infectious or contagious disease, not being foul brood of a virulent or malignant type, exists among the bees he shall give notice in writing to the beekeeper, instructing him as to the treatment of such disease and stating the time within which such treatment shall be given, and if at the expiration of such time the diseased colonies have not been treated by the beekeeper in accordance with the notice, the same may be treated by the Inspector and the beekeeper shall be liable to the Inspector for all expenses incurred in such treatment.
4. The Inspector may order the owner or possessor of any bees dwelling in box or immovable frame hives to transfer them to movable frame hives within a specified time, and in default the Inspector may destroy or order the destruction of such hives and the bees dwelling therein.
- 4a. For the better prevention of foul brood, the Lieutenant-Governor in Council may, on the recommendation of the Minister, declare a quarantine of bees at any point within the Province and may fix the duration of such quarantine and all other conditions in connection therewith, and any Inspector appointed under this Act shall have full authority to inspect bees in such quarantine when directed so to do by the Minister.
- 5.—(1) The owner or possessor of an apiary shall not sell, barter, give away or remove

from the premises any bees or used apiary appliances or apparatus until he has secured a permit from the Provincial Apiarist that such bees, used apiary appliances or apparatus have been properly disinfected and are free from disease.

- (2) Bees or used apiary appliances or apparatus shall not be imported into Ontario from any other Province in Canada or from any State in the United States of America unless accompanied by a certificate from a provincial or state officer certifying that such bees, used apiary appliances or apparatus are free from any infectious or contagious disease, but this shall not apply to the importation into Ontario of bees apart from combs.
- (3) Every person who contravenes the provisions of subsection 1 or of subsection 2 of this section shall be guilty of an offence and shall incur a penalty of not less than \$50 nor more than \$100.

6. Any person whose bees have been destroyed or treated for foul brood who sells or offers for sale any bees, hives or appurtenances of any kind after such destruction or treatment and before receiving a permit from the Provincial Apiarist so to do, or who exposes in his bee-yard, or elsewhere, any infected comb honey or other infected thing, or conceals the fact that such disease exists among his bees, shall incur a penalty of not less than \$20 or more than \$50, or he may be imprisoned for a term not exceeding two months.

7. Any owner or possessor of bees who refuses to allow the Inspector to freely examine bees, or the premises on which they are kept, or who refuses to destroy the infected bees and appurtenances, or to permit them to be destroyed when so directed by the Inspector, shall, in the complaint of the Inspector, incur a penalty of not less than \$25 and not more than \$50 for the first offence, and not less than \$50 and not more than \$100 for the second and any subsequent offence, and the convicting justice shall, by the conviction, order the said owner or possessor forthwith to carry out the directions of the Inspector.

8. Where such owner or possessor of bees offers resistance to or obstructs the Inspector, a justice of the peace may, upon the complaint of the Inspector, cause a sufficient number of special constables to be sworn in who shall, under the directions of the Inspector, proceed to the premises of such owner or possessor and assist the Inspector to seize all the diseased colonies and infected appurtenances and burn them forthwith, and if necessary the Inspector or constables may arrest the owner or possessor and bring him before a Justice of the Peace to be dealt with according to the provisions of the next preceding section.

9. Before proceeding against any person before a Justice of the Peace, the Inspector shall read over to such person the provisions of this Act or shall cause a copy thereof to be delivered to him.

10. Every owner or possessor of bees, and any other person who is aware of the existence of foul brood either in his own apiary or elsewhere, shall immediately notify the Minister of the existence of such disease, and in default of so doing shall incur a penalty of \$5.

11. Each Inspector shall report to the Minister as to the inspection of any apiary in such form and manner as the Minister may direct, and all reports shall be filed in the Department of Agriculture, and shall be made public as the Minister may direct or upon order of the Assembly.

11a. The Minister of Agriculture, with the approval of the Lieutenant-Governor in Council, may make regulations,—

- (a) prescribing the form of application for registration;
- (b) for fixing the fees to be paid for registration and upon a certificate of registration;
- (c) for the registration of beekeepers and prescribing the form of the register and the particulars to be entered therein;
- (d) for requiring beekeepers to make such returns and to furnish such information to the Department as may be deemed necessary or desirable;
- (e) generally for the better carrying out of the provisions of this Act.

12. *The Ontario Summary Convictions Act* shall apply to all prosecutions for offences against this Act.

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BULLETIN NO. 378]

[NOVEMBER, 1934

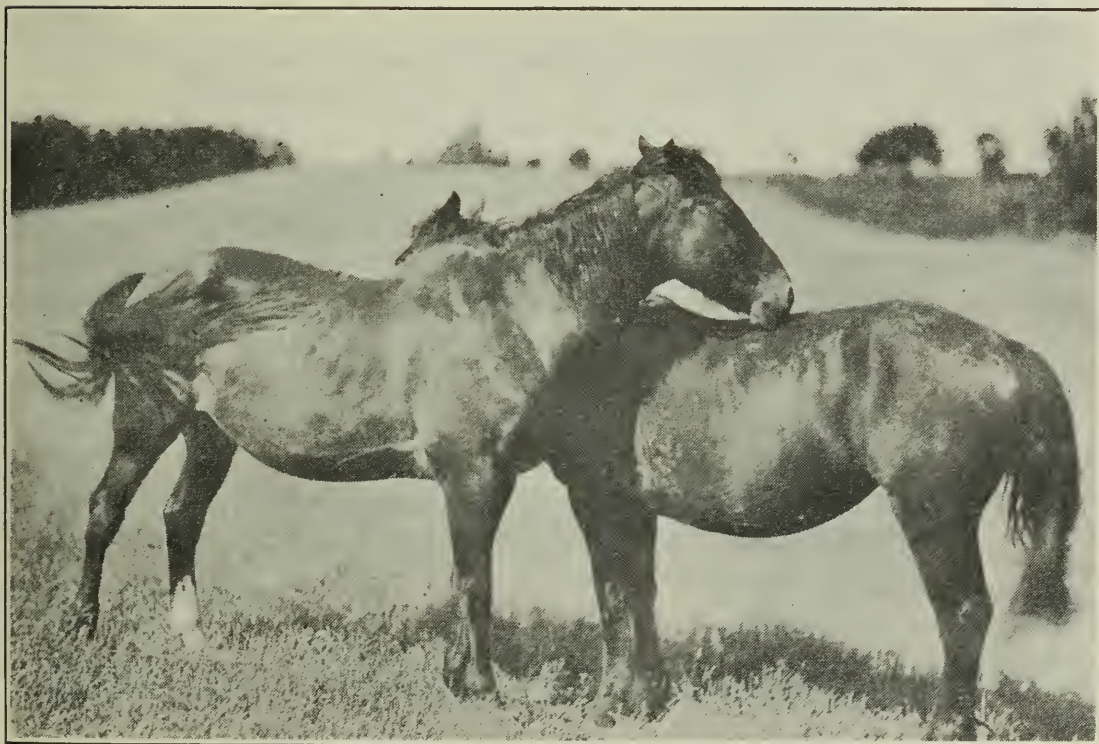
Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

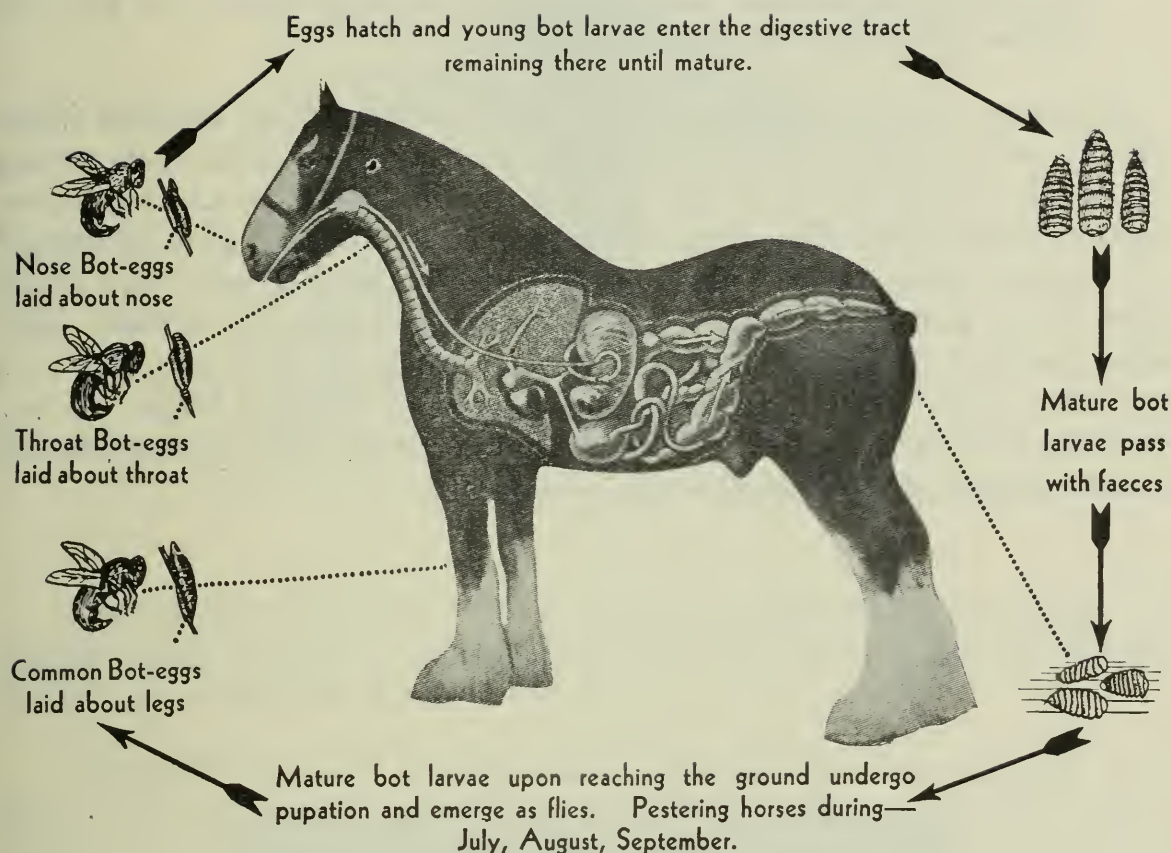
BOT FLIES AND THEIR CONTROL

LIONEL STEVENSON, B.V.Sc., M.S.

PROVINCIAL ZOOLOGIST



Horses annoyed by Bot Flies, try to protect lips and throat
by standing in position shown.



There are three varieties of bot flies, in Ontario, that attack horses and cause them much annoyance and hardship. The pest is becoming more numerous and irritating, due to the spread of two recently introduced varieties the Chin Bot Fly and the Nose Bot Fly.

The Bot Flies should be controlled for the following reasons:

- A. During the warm period of the year horses are much annoyed by the persistent egg laying efforts of the female bot fly.
- B. During the winter and spring seasons, bot fly larvae located in the stomach, cause interference with normal digestion and also seriously injure the mucous membrane lining the stomach.
- C. During the winter and spring horses become unthrifty and subject to colic, due to the presence of bot fly larvae.
- D. During the spring season bot larvae attached to the membrane lining the rectum of the horse cause much irritation.

E. The Bot Flies cause a heavy loss. This loss is difficult to estimate for the horse population of Ontario; but every horse owner knows that the work in the fields is made harder, that runaways are common, that broken harness, broken machines and injured horses are due to Bot flies. Many horse owners also are aware that, the unthrifty poor condition of many horses that are subject to digestive disturbances and colic is most frequently caused by Bot Fly larvae infestation in the stomach.

All these troubles if measured in dollars on the 200,000 Ontario farms where horses are kept, would represent a tidy sum. A worth while saving could be made if horse owners would do their full duty in protecting horses from the Bot Fly pest. Two points of attack have proven highly successful in the districts where any attempt at Bot Fly control has been made, destroying of Bot Fly eggs and the destroying of Bot Fly larvae. Any efficient method of killing eggs and larvae, when put into practice in a large way, must result in a successful control of the Bot Flies. It is a project for community effort, where the horse owner, the veterinarian and the Agricultural Representative can co-operate.



A first stage larva of the Horse Bot Fly. Note the head hooks.

A first stage larva of the Chin Bot Fly. Note head hooks and spines.



The Common Horse Bot Fly (*Gastrophilus intestinalis*)

The common horse bot fly (*Gastrophilus intestinalis*) is a large (five-eighths inch) brownish yellow, hairy fly with dark abdominal bands, a whitish face and dark spots on the wings.

The common horse bot fly which generally deposits its eggs on the hair of the fore legs, shoulder and neck of the horse, has been a pest to Ontario horses since the beginning of Ontario Agriculture. This bot fly (female) by its persistent efforts to deposit its eggs annoys the horses, causing unrest, stamping and switching. The eggs are whitish yellow in color, cling to the hair and may be readily seen. Hatching takes place in ten or more days if the conditions of moisture and friction are favorable. The young larva on leaving the egg shell, crawls on or bites into the skin, causing an irritation which the horse attempts to relieve by nibbling at the point of pain. This nibbling and rubbing with the teeth and lips, provides the way for the young larva to enter the mouth of the horse. The nibbling and rubbing also supplies the moisture and friction, a necessary aid to breaking open these bot fly eggs. The bot fly larva on entering the mouth of the horse burrow into the mucous membrane of the mouth, tongue or pharynx, and proceed in the direction of the stomach, which organ it enters by boring through its wall. The migration of the young larva from the mouth to the stomach is by way of the tissues bordering the esophagus, taking about four weeks. On entering the stomach, the young larva attaches its head hooks to the mucous membrane and remains in position as a parasite for nine or ten months while growing to full larval maturity. At the end of the period of larval development on the stomach mucous membrane, the bot larvae release hold, and pass out of the stomach into the intestine and finally drop to the ground with the faeces. The

larvae are capable of some movement when cast from the horse and they are also very resistant to weather conditions. The pupa stage or transformation from bot larva to bot fly is accomplished under favorable weather conditions in from four to five weeks, resulting in a new bot fly that is instinctively attracted to horses by horse odor, to begin the pestering all over again.



The Chin Bot Fly (*Gastrophilus nasalis*)
(Female Much Enlarged)

The Chin Bot Fly (*Gastrophilus nasalis*) is a large (one-half inch) hairy fly, the abdomen of which has a large black band and is covered at base and end by grey hairs, the thorax is reddish in color with a fringe of dark orange hairs, the face is yellow and the wings are clear. The Chin Bot Fly gets its common name from its habit of depositing its eggs on the hair of the throat and intermaxillary space. It is a recent introduction, coming to Ontario in its larval form as a parasite in horses imported from Western Canada. This fly has found conditions satisfactory for its increase in Ontario and is now to be found in every county where Western horses have been used. It appears as a tormenting pest early in July and continues until checked by frost in October. The eggs of this fly are yellow in color and at time of deposit become firmly attached to the hair, quite close to the skin. On hatching the young larva may penetrate the skin at a point near where the egg was attached or migrate on the skin surface to reach the lips. The larva once through the skin or in the mouth, migrates backward toward the base of the tongue and pharynx. The migration is continued in the tissues surrounding the esophagus until the stomach wall is reached. This is penetrated in due course and the larva then attaches itself by its head-hooks to the stomach mucous membrane, where in eight

to ten months it completes its larval life. This development attained, the larva releases hold and passes out of the stomach, on through the intestines to drop to the ground. Pupation or change from larva to fly is completed in less than five weeks. The new fly emerges, seeks a mate, and if a female starts egg laying. The life as an adult fly is probably less than ten days. The next generation is provided for in the eggs that they deposit on the horses during their short adult life. Destroy the eggs and there can be no Chin Bot Flies or other Bot Flies. If you fail to destroy the eggs then do not fail to destroy the grubs or larvae, when they are all collected in the stomach of the host horse.



The Nose Bot Fly (*Gastrophilus haemorrhoidalis*)
(female much enlarged, normally about
one-half inch in length.)

The Nose Bot Fly (*Gastrophilus haemorrhoidalis*) is a large hairy fly (about one-half inch long), the base of the abdomen is dark with a yellowish band and dark red tip, the wings are clear, the thorax dark with yellow fringe, the head is quite dark in color.

The common name Nose Bot Fly is due to the habit of the female Fly depositing her eggs on the lips or nostrils of the horse. This bot fly was introduced into Ontario and distributed with Western horses, during the past 15 years. This bot fly is on the increase in Ontario and complaint of its activities are heard from horse owners in every county. The egg laying female Nose Bot Fly is very active during the harvest season, July and August. Its habit of darting at the lips of the horse causes much annoyance and fright. The lips of the horse being very sensitive, the mere strik-

ing and attaching of the egg to hair or skin, causes the horse to rub its lips or throw its head violently in attempts to frustrate the Nose Bot Fly. The tangling up of horses, harness and machinery, with breakage and run-aways are commonly due to this fly. The eggs of the Nose Bot Fly are dark brown or black in color and longer than the eggs of either of the other bot flies attacking horses. The eggs are not easily seen and must be looked for on the lips of the horse. Unlike the eggs of the other bot flies the eggs of the Nose Bot Fly hatch very soon after being placed on the lips. The route into the horse's mouth is very short, so it is easy for the young larvae to enter, when the horse is in the act of moistening its lips, by protruding the tongue. Other means of entry are direct penetration through the skin of lips, and sometimes with food while the horse is feeding. Such penetration by larvae may cause some irritation, and is the probable cause of a horse rubbing its lips on the ground or any hard object handy. The young larvae are found in the mucous membrane of the mouth, in the muscles of the tongue and in the tissue surrounding the esophagus or gullet, indicating the route of migration to the stomach. The larvae attach themselves to the stomach mucous membrane and remain in



See the holes in the membrane caused by the Bots.

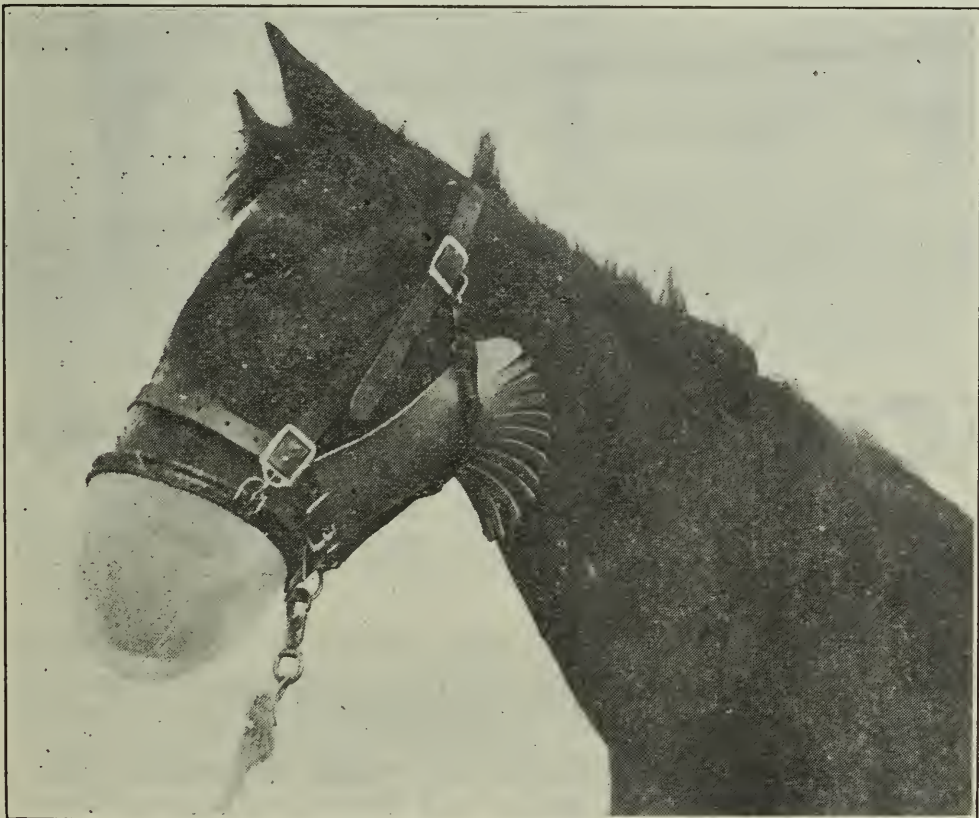
Section of the stomach from horse, showing bot larvae in position and an injured membrane on area from which the bot larvae were removed, previous to photo being taken.

position for about six months, they then detach and migrate to the large intestine, where they again attach themselves to the mucous membrane of the rectum, remaining in the last mentioned location for about four months. At the end of the ten months of larval life the grubs pass from the rectum, falling to the ground where they go through a pupation period of about 5 weeks. Emerging from the pupa case the new fly is attracted to a mate and then to the horses, where it demonstrates its ability as a pest.

CONTROL OF BOT FLIES

- A. Use devices on the horses to prevent fly depositing its eggs.
- B. Kill the eggs before such can hatch.
- C. Kill the larvae while they are in the stomach of the horse.

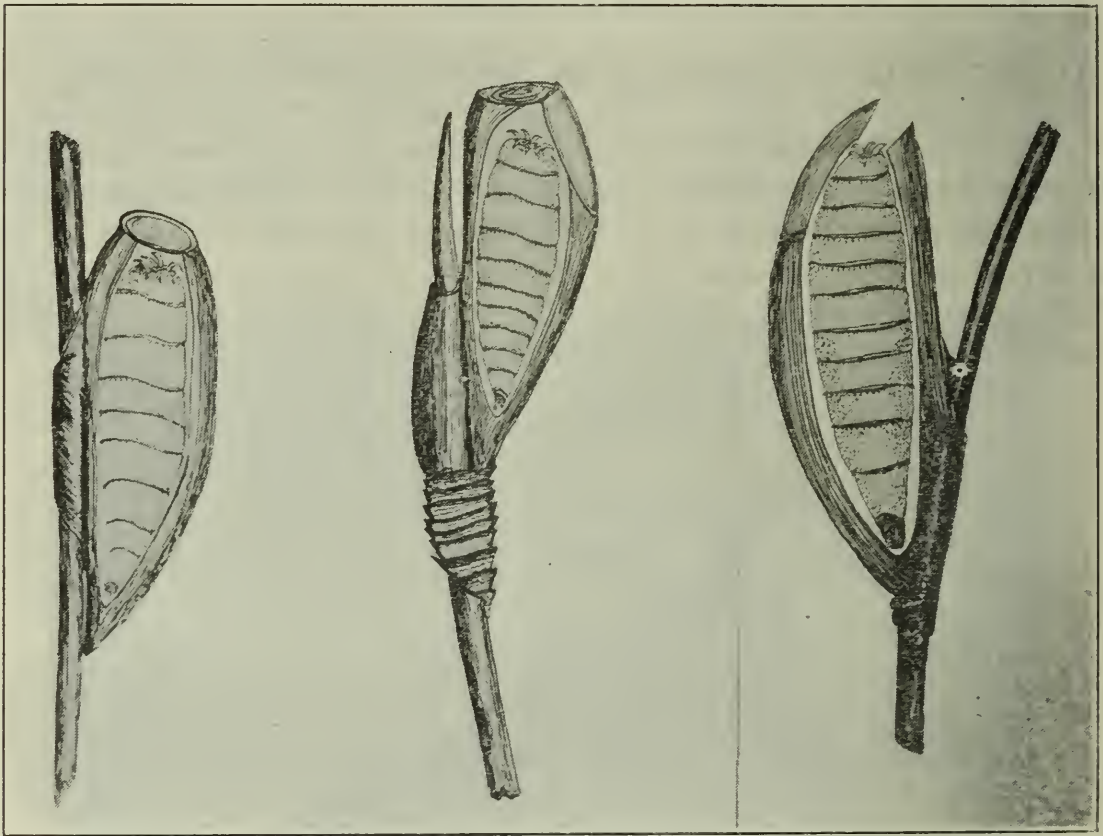
Devices can be used that prevent the Nose Bot Fly from depositing its eggs on the lips of the horse. Of these the wire basket guard shown in the illustration is the best as it gives ample protection if kept in place. This device can only be used while the horse is wearing a bridle or halter as it is fastened to such. Wire guards can be purchased at a cost of 25 to 40 cents, at hardware stores, or harness shops.



A Halter fitted with Nose Basket and Chin Guard, costs but little, and gives good protection against the Nose Bot Fly and the Chin Bot Fly.

A device that is useful in preventing the Chin Bot Fly depositing its eggs, can be made and attached to the bridle or halter worn by the horse. Such device is best made of light leather or canvas, sacking will do. It is shaped to cover the throat, sides of jaws and area between the jaws, as shown in the illustration above.

Devices that prevent the common Horse Bot Fly from depositing its eggs, are expensive to make and awkward to use. Nets that cover the neck, shoulder and legs can only be used while the horses are at work. It is far more practical to kill the eggs and the larvae for a few years and thereby reduce the pest to vanishing point.



The Egg of the Chin Bot Fly. Side of egg case cut away to show well developed larva. Note attachment to hair.

The Egg of the Nose Bot Fly. Side of egg case cut away to show development of larva. Note the peculiar attachment of egg to hair.

The Egg of the Horse Bot Fly. Side of egg case cut out to show development of young larva. Note attachment of egg to hair.

KILLING THE BOT FLY EGGS

This method of control is highly important in dealing with the Chin Bot Fly and with the common Horse Bot Fly, but is not practical with the Nose Bot Fly. The eggs deposited by the Chin Bot Fly and the common Horse Bot Fly are readily visible as small yellow objects attached to the

hair, most commonly noticed on legs, shoulders, neck and throat. While attached to the hair, the eggs can be easily killed. The killed egg can not hatch, so if all the eggs were destroyed, these bot flies would cease to exist. Those responsible for the care of horses could give up a few minutes once a week, to go over their horses and remove the bot fly eggs or soak them with a penetrating fluid to kill them where ever located. The following may be used—carbolic solution or stock dip solution, 2 percent strong. Just sponge over the area where the eggs are attached. Light oils may be used with fair results. Eggs may be removed with a sharp knife, or a very fine steel comb, or with safety razor. Colts and horses at pasture should be rounded up every week during bot fly time and the eggs killed or removed. If the horse owner will make a thorough job of egg killing or removal, his horses will not be infested with bot fly larvae during the following winter.



Stomach of Horse with wall cut away to show Bot Fly Larvae in the pyloric end of the organ.

KILLING THE BOT FLY LARVAE

A veterinarian's job. If the eggs are permitted to hatch, the young larvae will reach the stomach. All will be there by mid-December, as no eggs hatch on horses after freeze-up, if they have been exposed to frost. Freezing will kill bot fly eggs. The migration of the young larva from mouth to stomach takes about four weeks. Knowing this, we can add four weeks to the date when heavy killing frosts occurred to determine the date when all the larvae will have reached the stomach. In Southern

Ontario this is usually about December 15th. After February 1st it has been noted that the young grub or larva of the Nose Bot Fly, starts to leave the stomach and moves on through the small intestine, to attach itself to the membrane lining the rectum. So there is a period when all the grubs or larvae of the three varieties of Bot Flies are in the stomach, December 15th to February 1st. See that all the bot grub infested horses are treated then. Carbon di-sulphide is the drug commonly used. This drug is considered to be safe if administered by a competent veterinarian. It is the most efficient drug now widely used, for removing bot larvae. It must be administered in capsule or with stomach tube, by a veterinary experienced in capsuling horses.

CONSIDERATIONS IN THE USE OF BOT LARVAE TREATMENT

- A. A competent veterinary should be employed to administer the drug used.
- B. City horses and horses kept in stable all the year and not exposed to bot flies are not likely to be in need of treatment.
- C. Horses to be treated should be prepared by having the stomach well cleared of food. No feed for 12 hours and no water for 2 hours previous to the administration of the carbon di-sulphide capsule is advised. And no water or feed for 4 hours after being treated.
- D. If two ounces of water is injected into the horse's mouth after the capsule has been placed or when it is placed, complete and easy swallowing is assured.
- E. Horses that are permitted to eat a handful of oats, just before being capsuled will swallow more readily.
- F. Great care should be exercised by horse owners in bringing hungry and thirsty horses back to feed, or colic is apt to develop from over-eating or over-drinking. Limited quantities of laxative feed to start and be careful of ice-cold water.
- G. With aged and debilitated horses it is best to divide the regular dose into two portions, and have same administered one hour apart.
- H. Colts should be given a dose in keeping with their weight.
- I. Horses known to be ill from any cause, should not be treated with carbon di-sulphide until they return to normal.
- J. Horses suffering from serious organic disease should not be treated.
- K. Brood mare far advanced in pregnancy should not be treated.

AREA ORGANIZATION

Where the Horse Owner, the Veterinary and the Agricultural Representative can co-operate fully, the cost of treating horses for the removal of Bot Fly Larvae, is very low. The larger the percentage of horses treated in any district, the better for all concerned.

Counties, townships, school sections, or concession lines can be the unit of work where organization is undertaken. School sections are the usual unit. A committee of two horse owners, the veterinary and the Agricultural Representative, decide on the plan to be adopted for each small unit. There are two plans for handling the work, (1) treating the horses on their home farm or (2) having the horses assembled at one farm or other meeting place. Both plans have worked well in Ontario during 1933. Under plan (1) all the horses and colts are treated, more of the Veterinary's time is required. Under plan (2) unbroken colts are not likely to be taken to meeting place, and are therefore missed. However when travel is difficult the assembly of horses at one point aids the Veterinary and speeds up the work. Plan (2) under which horses are assembled, may aid in the spread of strangles.

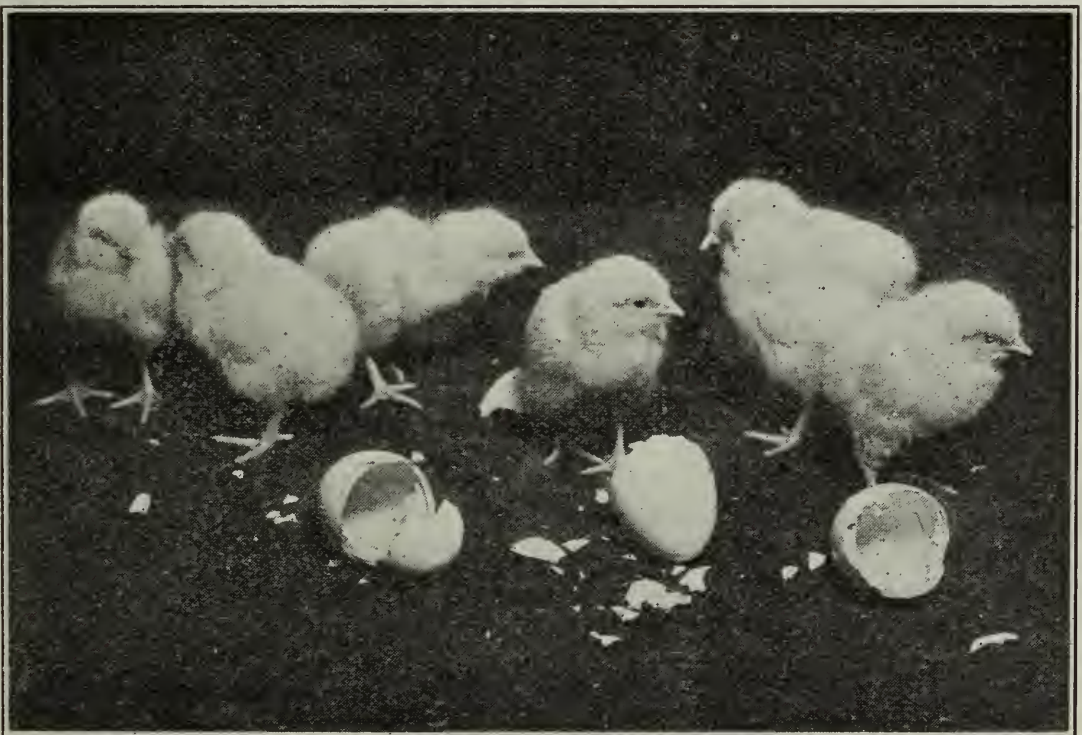
The fee charged for treating horses should be large enough to provide an insurance fund; that would take care of any loss that may be charged to treatment. Horses may die due to causes other than treatment, but the treatment may be blamed hence providing insurance in area organization for bot control is advised.



ONTARIO DEPARTMENT OF AGRICULTURE
ONTARIO AGRICULTURAL COLLEGE

FARM POULTRY

BY THE STAFF OF THE
DEPARTMENT OF POULTRY HUSBANDRY



There are many perplexing questions in connection with successful poultry raising on the farm. This bulletin answers some of them and will help the reader to find answers to others.

EGG PRODUCTION

It is generally considered among poultrymen that the production of eggs is the most profitable branch of the business. It must also be conceded that for most people a crop of chickens must be reared annually, and the surplus males and old hens sold, at a profit if possible.

Many believe that the secret of getting eggs, particularly in Winter, is in the feeds given and in the method of feeding; others believe the whole problem is in the breed, variety or strain; while still others think that the housing is the problem to solve. All these are important but the main reason for poor results, in the opinion of the writers, is a lack of careful work performed months before the eggs are wanted. While you are collecting the high-priced Winter eggs you should be making careful plans to secure the crop of pullets for the next season.

The factors influencing production are as follows: Feeding, housing, age of stock, strain, possibly breed, attendance, cleanliness and the weather. All of these may be more or less controlled, with the exception of the weather and it is perhaps the least important factor.

Some trouble is caused through over-crowding of the birds in the houses and having stock of mixed ages in the same pen. Often yearling and older hens are housed together with early and late pullets, as well as surplus cockerels. The pullets should be separated from the older females and any spare cockerels disposed of or housed by themselves. Dirty, damp and draughty houses, along with wet and badly soiled litter, are other causes of trouble.

Where Winter eggs are wanted, the early hatched pullet is, without doubt, the one to depend upon. Yearling and older hens are very rarely good producers during November and December. They are uncertain producers even in January and February and really do not begin to lay well until March unless artificial lighting is used. Where the egg production falls below twenty-five per cent during the Winter months one is not making much profit. The age at which most pullets begin laying is from six to seven months. Some lay at four and one-half to five months, and others not until eight or nine months of age. This means that if a fifty per cent egg yield is wanted in November the pullets should be

hatched during March or April. May hatched pullets will lay moderately well but, as a rule, not over forty per cent daily.

The attendant has responsibilities. There should not be any neglect on his or her part, but careful, constant, regular attendance and a keen interest in the welfare of the birds. A bird that has stopped laying is very hard to bring back into production. As pullets mature they commence laying. It is the attendant's work to keep them going.

The amount of feed a hen will consume, the number of eggs she will lay, and the time at which she lays the eggs, are interesting and important factors. Available data would indicate that one hundred to one hundred and ten eggs per year will pay for a hen's keep, depending on the market prices for feed and eggs, and provided the flock mortality is not in excess of ten per cent.

The body weight must be maintained or increased if production is to be kept up.

The amount of feed consumed varies with the breed and with the number of eggs produced. Our figures show that the general purpose breeds, such as Plymouth Rocks, Rhode Island Reds and Wyandottes, consume from eighty to ninety pounds of grain and mash annually, averaging nearly seven pounds of feed each month. Breeds such as Leghorns or Anconas eat from fourteen to eighteen pounds less per year; or in other words, the large breeds eat more than the small ones and the heavy layers eat more than the poor layers. The amount of feed required cannot be stated in ounces per bird for each day as birds' appetites vary, similar to human beings. The successful feeder studies his flocks and regulates the amount of feed to be given according to the condition and requirements of his flock. The writers are of the opinion that there are more hens that are too lean to lay than there are hens that are too fat to lay. Most very fat hens are poor layers and are better put on the market than fed sparingly to try to condition them for laying.

The common practice is to feed about one-half of the grain as scratch feed or whole grain, and the balance as ground mixtures or mashes.

There is a demand for information as to exactly how much to feed one hundred hens daily. This number of laying hens would eat about twenty-three pounds of feed daily, or say twelve pounds of scratch grain and eleven pounds of mash. Hens are inclined to eat more mash in the Spring and Summer months than during the Winter months.

It is not good practice to feed an exact amount daily because the hens' appetites vary according to the weather conditions and the rate of egg production.

Our method is to feed about four pounds of scratch grain per hundred birds, in the litter, in the morning. We generally give a moist mash at noon, giving the birds all they will clean up in fifteen minutes. At night a full feed of grain is given in a trough and any that is not eaten is removed. The dry mash is fed in a hopper and is constantly before the birds. The hopper should be large enough to allow a feeding space of one foot for each four or five hens. The amount of mash put in the hoppers should be such that it is cleaned up daily. Fresh feed is eaten

more readily than after it becomes stale. This plan insures that the birds have all they desire to eat daily.

Hens usually ease off in egg production owing to a loss in body weight, hence the importance of having them consume approximately equal quantities of grain and mash.

The Art of Feeding. There is something in the art of feeding. A good feeder watches the condition of the droppings as seen on the dropping boards and also sees to it that the hens have plenty to eat but have no feed left in the litter. The appetites of the birds are keen and, moreover, the birds may like or dislike the attendant. There should be a friendly relationship between the attendant and the birds. Know your birds and have them know you. Be on friendly terms with one another.

FEEDS AND FEEDING

Fowl require a variety of feeds. While it is true that the whole grains, and the milling by-products from the same, form the major portion of the ration, it is absolutely essential that they receive also green feed, animal protein, water, grit and shell-forming material. All these feeds must be clean and wholesome. The drinking material should be constant in supply and may consist of water or milk or both. Where milk is given do not use galvanized iron or rusty containers. The supply must be clean because dirty water, dirty or slimy drinking dishes, etc., are probably the most common channels for the spread of disease. Most attendants are inclined to forget the importance of cleaning the drinking vessels and of keeping them well filled at all times.

Recent investigations with regard to nutrition have helped to clear up some points relative to feeds and feeding.

A complete ration contains all the necessary nutrients for health, growth, egg production or fattening. This means that such a ration is balanced in its tissue forming elements, such as contained in animal proteins, and in its heat and energy producing constituents, as are found in the cereal grains. It is also balanced in its mineral content, as commonly supplied in the form of oyster shell and bone meal, and includes the necessary supply of vitamins, as commonly found in tender green feeds, cod liver oil, and as activated by the ultra-violet rays in direct sunlight.

The experimental results to date suggest that the feeding of a variety of feeds is a safe practice. This applies in the use of cereal grain mixtures, such as corn, wheat, oats and barley, as well as in the use of animal proteins, such as milk, beef meal, fish meal, etc.

Any trials which we have made using a single cereal have always indicated that there is a deficiency of some nature in each grain and that this is also true of the animal proteins.

It is essential that the health of the bird be maintained and that there be a surplus of digested feed above that needed for body maintenance, to be used for growth or the production of eggs.

In general, it will be safe to state that grains such as wheat, oats, barley and corn, together with their mill by-products, maintain the body temperature and produce fat and egg yolks.

Such feeds as skim milk, dried milk, or any other of the many forms of milk, together with animal by-products such as meat meal, fish meal, raw liver and proteins of vegetable origin, go to the production of the muscle of the bird and to the making of the white of the egg.

Feeds such as bone meal, oyster shell and minerals from other sources are used to produce the bones of the body and the shell of the eggs.

The whole series is required to produce eggs. Many of the materials, other than those cited above, are found in small amounts. As an example, there is considerable calcium and phosphorus in milk and in clover leaves, and wheat bran also contains some bone-forming material.

An understanding of the feeding of poultry is helped materially by remembering that the bird can re-combine many nutrients, but can manufacture very little, if anything, not found in the ration.

A ration must be considered not only from the standpoint of its chemical composition, but also from its physical action, and it must be palatable.

It is also well to bear in mind that any change in the colour of the feed must be taken into consideration when one attempts to change the ration for the reason that many birds do not take kindly to the change and, moreover, it may change the colour of the yolks, which in turn may make a marketing difficulty. All changes should be gradual.

The physical factors influence the bulk of the ration or the weight per measured bushel and, likewise, the mechanical texture of the feed as to whether it is granular or sticky. Ground corn tends to be granular, whereas finely ground oat groats and wheat flour are sticky. Bran and clover leaves add bulk to the ration. Some feeds tend to be constipating, while others are of a laxative nature.

Where laying hens or growing chicks are given the free choice of a large number of feeds, prepared in different ways, it is seldom that very finely ground materials are selected. As an example, the birds prefer rolled or crushed oats to finely ground oats, so much so that they scarcely eat any finely ground oats where the crushed or rolled material is available. Where feeding space permits the placing before the birds of a large assortment of feeds, they will of free choice take in a great variety of these feeds.

The palatability of any mixture and its physical nature are important points.

Poultry that have been well fed during the growing stage are inclined to be sensitive to changes in feed mixtures, hence it is sometimes

difficult to change from coarse to finely ground feed. It is a good practice to grow the young stock on the kind of feed you intend to use during the winter season.

There are two distinct conditions that have to be considered in grain mixtures. There are the persons who grow their own grain and who do not want to buy any other feed, and there are those who are in a position to purchase feed to be combined in the best known manner.

A very skilful feeder will observe closely the general condition of the birds' appetites, their general actions and the condition of the manure, and will usually get results in growth and production which the ordinary feeder does not equal.

For most feeders a ration is desired that is as nearly fool-proof as possible; one that the birds may help themselves to at all times and with which the results will be positive, regardless of the efficiency of the attendant.

Laying hens, particularly during the Winter months, are sensitive to changes. Roughly speaking, if they have good care and feed for six days a week and the seventh day is not just what it should be, they are very likely to lay according to the attention given on the inefficient day.

RATIONS FOR LAYING HENS

Our experience suggests that there should be, if possible, three kinds of cereals available. Most people use as a scratch grain a mixture of about two parts whole wheat to one part of cracked corn. We have successfully used wheat, oats, barley, buckwheat and corn in grain mixtures. If care is used to make changes gradually we have no data that would suggest that any two, or preferably any three, of the above grains cannot be used. Elsewhere in the Bulletin are given the results of some experimental tests of the cereals in various combinations. While this work was done with chicks the results may, in some measure, apply in the case of older birds. This may be true more particularly in respect to the combination of cereals, as suggested above.

Herewith is given a number of rations for laying hens. These are based on the results of experimental work and offer some latitude in the use of home-grown materials.

Free Choice or Cafeteria Laying Mash

400	lbs.	ground yellow corn
100	"	corn feed, or yellow hominy
200	"	white hominy feed
450	"	rolled wheat
150	"	wheat germ
50	"	wheat bran
100	"	rolled barley

300 " crushed oats
 50 " Banner oat feed—or if you have not this, 50 lbs. oat middlings
 20 " ground peas
 20 " soya bean oil meal
 80 " meat meal
 30 " powdered milk
 30 " fish meal
 10 " cod liver meal—or if you have not the cod liver meal, raise the milk 10 lbs.
 10 " iodized salt
 1 pint cod liver oil to each 100 lbs. of the mash mixture.

Oyster shell, grit and bone meal are supplied in separate hoppers.

While using the Cafeteria laying mash with the breeding flock it would be advisable to replace the meat meal and fish meal with milk owing to its beneficial influence on hatchability, as shown in the experimental data as presented elsewhere.

Crushed Grain Laying Mash

Crushed or rolled grain is preferred by chickens to finely ground grains, particularly such grains as wheat, oats and barley. These grains when ground and wet are of a sticky nature and this may be the reason for the hens' preference for crushed grains. The refuse hulls should be removed daily.

Good results in egg production and hatching power of eggs were secured in 1934 and 1935 from a ration consisting of equal parts of:

Crushed Oats
 Crushed Wheat
 Crushed Barley

To each one hundred pounds of the above grains was added one quart of a good grade of cod liver oil from November 1st to April.

It is necessary to feed some clover leaves or hay and to supply animal protein such as milk powder, beef meal or fish meal, or all three, in separate hoppers or containers. These feeds do not mix well with crushed grains. Birds to date have shown no disposition to eat an excess of these materials if supplied constantly.

Skim milk or buttermilk fed at the rate of twenty-five pounds daily to each hundred hens, provides enough animal protein without supplying any other, such as fish meal or meat meal.

The best hatches were secured from the eggs laid by hens receiving milk only as the animal protein.

Supply a hopper each of grit, oyster shell and bone meal.

If care is given as to feeding a reasonable amount of crushed grain daily, there will be little wastage. Where the birds are forced to eat all the hulls there is at times trouble with their gizzards becoming impacted sufficiently to cause death.

Feed scratch grain, as usual, of the kinds of grain you have. You could feed whole wheat as scratch grain, and crushed oats and barley as a mash.

Laying Mash

500	lbs.	ground barley
200	"	chopped or ground yellow corn
300	"	ground oats
500	"	shorts
50	"	oil cake meal
15	"	iodized salt
150	"	alfalfa meal
125	"	powdered buttermilk
60	"	fish meal
40	"	meat meal
3	gals.	cod liver oil.

This formula is made with the idea that hens fed the mash will lay well and, at the same time, produce an egg that will hatch moderately well.

A number of people wish to use home-grown feeds and are asking how changes in the ration can be made to use such feeds.

Barley is used in this ration as a substitute for an equal quantity of corn where the latter is relatively higher in price. Barley is low in vitamin A and is slightly high in fibre. Usually one need not worry about this amount of fibre but the vitamin A is essential.

Ground wheat could be substituted for the shorts, or some bran and low grade flour may be used.

Mixed grain may be substituted for all the grain mixture in the above mash provided it does not contain more than 40 lbs. of oats to the hundred pounds of mixed grain. If it has too many oats one should sift out a considerable quantity of the oat hulls, and the grain mixture will answer. Rolling or crushing the barley, oats and wheat would probably improve the physical condition and palatability of this mash.

The oil cake meal is put in the ration mainly to regulate the bowel action.

Ordinary fine table salt will do, but we prefer to use iodized salt since there may be an iodine deficiency in some localities.

Alfalfa hay or clover leaves, or even fine cut clover hay, may be substituted for the alfalfa meal. This may be fed in wire baskets.

If there is available an ordinary pailful of skim milk for each hundred hens per day all the powdered milk, fish meal and meat meal may be left out of the ration. Powdered milk is easily mixed into a ration, and milk in one form or other appears to materially improve the hatching power of eggs.

The cod liver oil is essential during the Winter months to aid in making available the minerals, and is a good substitute for sunshine.

The protein feeds (milk, fish and meat meal) are used in the production of egg whites. The yolk is formed chiefly from the grains. The clover and alfalfa meals and the cod liver oil supply some of the essential **vitamins**.

The minerals for the above ration are fed in hoppers. Some form of available calcium carbonate is essential for shell forming material. Oyster shell answers this purpose. Many good poultrymen supply, in addition, a hopper of hard rock grit and also a hopper of charcoal.

This mash is constantly before the birds.

NOTE: The results reported in this Bulletin regarding the dosage of cod liver oil are based on the use of medicinal cod liver oil at a minimum of one-half of one per cent of the total ration. If oils of lower potency are used it may be found necessary to use a larger dosage. If using a fortified oil the dose could be reduced according to the degree of fortification.

FEEDING CONCENTRATES

High Protein Feeds

Several concentrate mixtures are sold by the trade. In most instances these feeds are recommended to be fed mixed with home-grown grains. With the grinding or crushing of some home-grown grains it is difficult to make a thorough mixture of all the ingredients.

During the past two years we have been doing a little experimental work with placing the concentrate in a separate hopper or container and trusting the birds to eat what they require. We were interested, primarily, in ascertaining whether the birds over-eat of the concentrate, whether such a method is economical, and whether the birds eat more than they require.

There has not been sufficient data to warrant a positive statement but where chickens were grown on a reasonably good ration they have not consumed more concentrate than is recommended in most mixtures. Separate containers of powdered milk, semi-solid buttermilk, fish meal, meat meal, mixtures of milk, meat and fish, as well as liquid milk, have been given the birds.

Where liquid milk is given, a twenty-five pound pailful daily for one hundred laying hens has given ample protein supply. It is worthy of note that hens on a milk ration eat much more bone meal than they do on a ration of meat meal or fish meal.

When using a concentrate during the Winter the attendant should be sure to supply cod liver oil at the rate of a teacupful daily to three hundred hens. This may be poured on the whole grain, in which case the grain would be fed out of a trough to avoid contact with filth and dirt from the litter, by oily grain given in scratching material. The oil may be mixed easily when a moist mash is fed but is difficult to mix with finely ground grains.

Fifty laying hens will eat about one pound daily of meat meal when fed separately, which appears to be expensive but is not more than is mixed into many mashes.

The birds' appetites for concentrate vary, depending much upon whether they are laying or not.

TABLE NO. 1—FEED CONSUMED

Description	Milk	Grain	Mash	Grit and Shell	Special Animal Feed	Eggs Laid
	lb.	lb.	lbs.	lbs.	lbs.	
2375 Barred Rock Pullets	235,698	128,102	42,625	6,372	.....	381,503
Av. per bird	99.24	53.51	17.94	2.21	.....	160.6
1312 White Leghorn Pullets..	102,963	50,535	23,725	3,233.5	1,569.5	197,813
Av. per bird ..	76.11	38.51	18.08	2.46	1.19	150.7

In Table No. 1 are given the results of some investigation in feeding. The work has been carried on over a period of six years with Barred Plymouth Rock and Single Comb White Leghorn pullets hatched at different dates between March 1st and May 31st. The birds were, for the most part, kept under rather closely confined conditions, the yard providing in most cases only sufficient room to allow the birds to get out of the pen and onto the soil.

In computing the above data, feed used in the form of green feed was not included. The main consideration in this connection, however, was the oats used for sprouting purposes. It is difficult to determine the exact amount of this particular feed consumed by each bird. In observations and calculations made during the four year period, during which time sprouted oats were fed throughout the entire year, it was found that the consumption was approximately fifteen pounds for Leghorns and seventeen pounds for Rocks. Thus it will be found that if these amounts are added to the amounts of grain and mash given in the above table that the total grain consumption per bird per year was for Leghorns 71.59 lbs., and for Rocks 88.45 lbs.

A study of the distribution of the egg production is interesting and important from the standpoint of the annual returns from the birds. Egg prices rise and fall with the seasons and usually the greatest profit is made where producing eggs at a season or seasons of the year when prices are high.

Pullets are the chief source of egg supply. As stated previously, they require usually from six to seven months in which to mature. It is therefore possible to regulate their production in the Fall months, at least to some extent, by regulating the time they are hatched in the Spring. Below is given the average percentage monthly egg production of Barred Rocks and White Leghorns hatched in March, April and May for a period of six years.

TABLE No. 2. AVERAGE PERCENTAGE MONTHLY EGG PRODUCTION FOR 2,375 BARRED ROCK PULLETS HATCHED IN MARCH, APRIL AND MAY.

Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	25.79	44.04	43.94	40.71	38.72	41.39	53.29	57.06	56.98	51.96	46.23	48.46	.....	.....	166.84
April .....	.....	17.79	36.44	43.25	39.79	45.90	57.06	61.25	56.13	53.12	48.48	46.43	39.22	.....	165.75
May .....	.....	.....	12.17	30.46	32.36	38.69	48.44	53.94	56.61	50.67	49.09	45.98	43.24	31.17	149.90

TABLE No. 3. AVERAGE PERCENTAGE MONTHLY EGG PRODUCTION FOR 1,312 WHITE LEGHORN PULLETS HATCHED IN MARCH, APRIL AND MAY.

Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	20.80	40.48	35.81	35.43	35.59	40.34	47.93	43.66	54.43	55.62	45.19	40.15	.....	.....	150.67
April .....	.....	14.68	42.17	38.05	35.86	40.42	46.41	44.63	59.90	56.22	46.14	39.48	30.97	.....	150.52
May .....	.....	.....	18.66	37.32	44.64	47.12	52.59	51.97	61.66	54.65	46.77	44.52	42.67	26.65	160.96

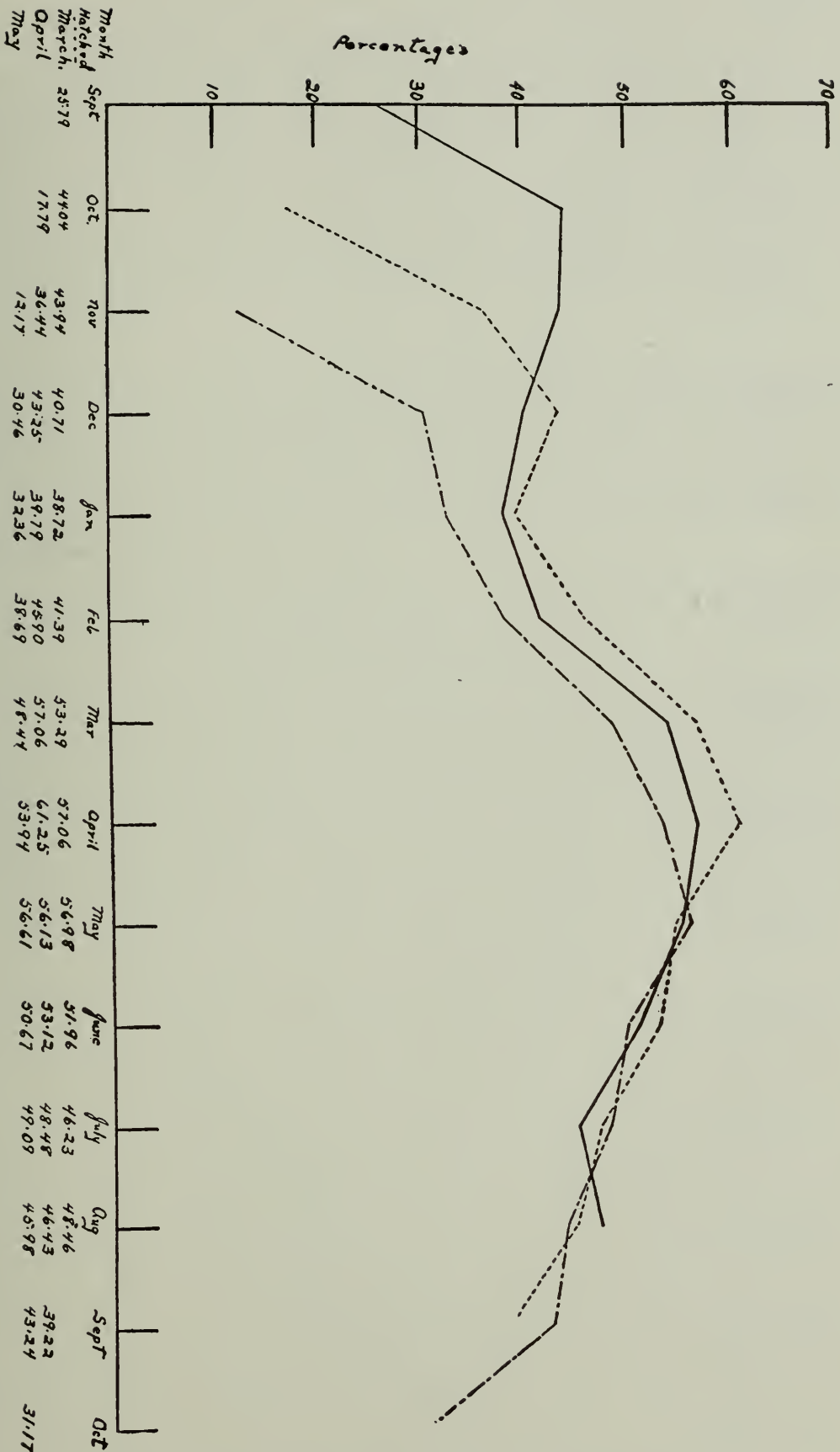
In the following tables is given the average monthly egg production per bird for three groups of Barred Plymouth Rocks and three groups of Single Comb White Leghorns hatched in March, April and May.

TABLE No. 4. AVERAGE MONTHLY EGG PRODUCTION PER HEN FOR 2,375 BARRED ROCK PULLETS HATCHED IN MARCH, APRIL AND MAY.

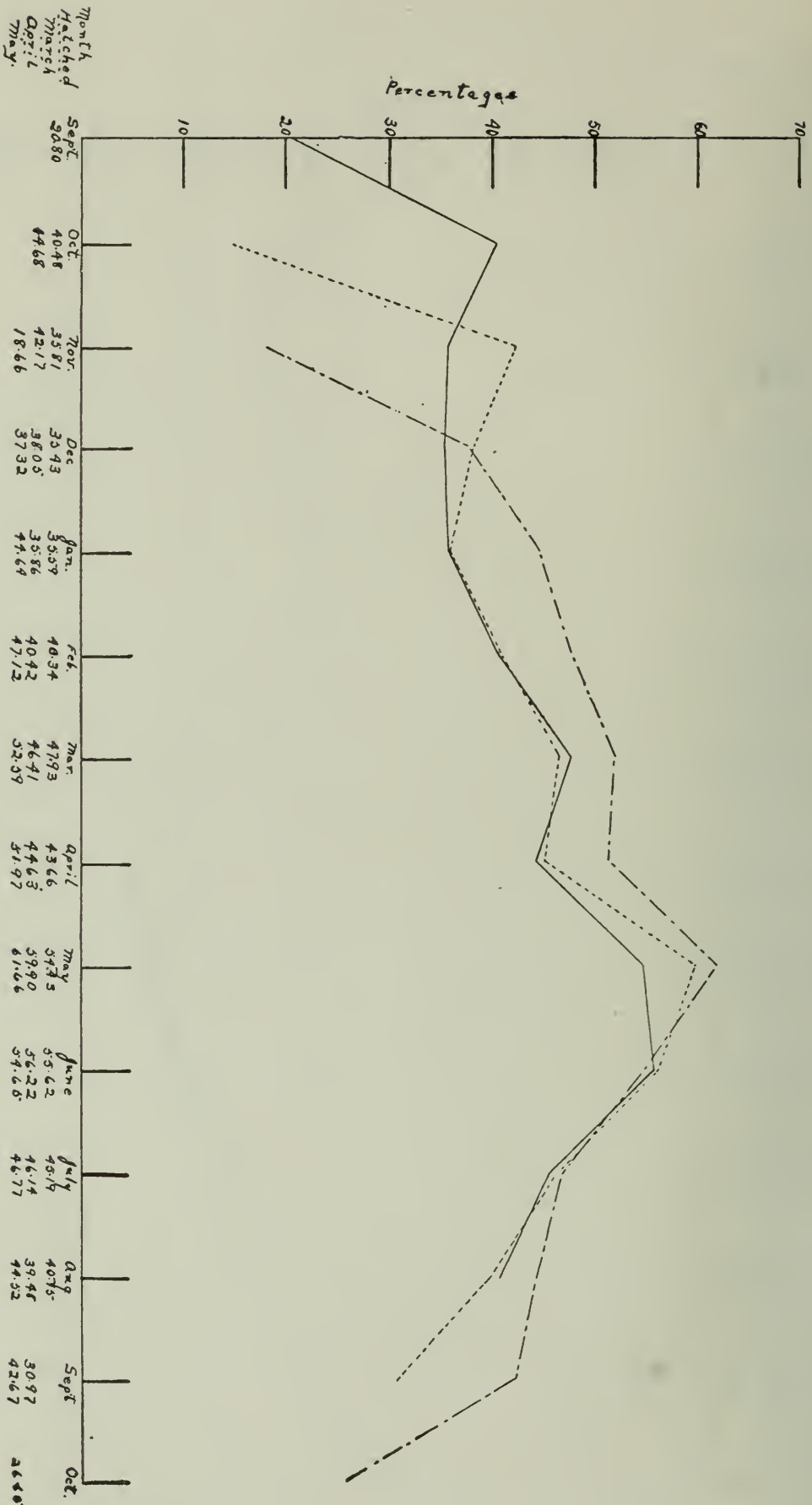
Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	7.71	13.64	13.17	12.60	12.00	11.58	16.50	17.11	17.65	15.57	14.31	15.02	.....	.....	166.84
April .....	.....	5.51	10.93	13.42	12.36	12.86	17.70	18.37	17.40	16.00	15.03	14.40	11.77	.....	165.75
May .....	.....	.....	3.65	9.44	10.03	10.83	15.07	16.17	17.50	15.20	15.22	14.25	12.97	9.66	149.90

TABLE No. 5. AVERAGE MONTHLY EGG PRODUCTION FOR 1,312 WHITE LEGHORN PULLETS HATCHED IN MARCH, APRIL AND MAY

Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	6.24	12.55	10.74	10.98	11.03	11.29	14.85	13.10	16.77	16.68	14.00	12.44	.....	.....	150.67
April .....	.....	4.55	12.65	11.79	11.12	11.31	14.39	13.39	18.57	16.99	14.21	12.27	9.28	.....	150.52
May .....	.....	.....	6.59	11.67	13.84	13.19	16.30	15.29	18.85	16.00	14.50	13.80	12.80	8.26	160.96



Graph. 1. Percentage Egg Production by months of three groups of Barred Rock Pullets hatched during the months of March, April and May.



Graph 2. Percentage of Egg Production by months of three groups of White Leghorn Pullets hatched during the months of March, April and May.

In the foregoing tables it will be noted that the average annual production is practically the same for different dates of hatching. It would therefore appear that so far as total production is concerned there is little to be gained by early hatching. If, however, the reader will compare the production figures for the different months, and the different groups, he will find that the early hatched birds produced a moderately large number of eggs in the Fall when prices were high, before the later hatched birds got started. This difference is very graphically shown in Graphs 1 and 2. There is the further advantage in early hatching, especially with early March hatched chicks, in that the cockerels can often be brought to broiler weight while the price for broilers is still good and the cockerels can be marketed, thus giving the pullets a better chance to develop.

Viewing the matter from the purely economic standpoint of egg production, it is interesting to compare the values of the eggs produced by birds hatched during different periods on the basis of current market prices for eggs at country points. Below is given the average monthly price of eggs per dozen on the Grade A Large, or its equivalent, at country points in Ontario for the seven years, January 1st, 1928, to December 1st, 1934.

TABLE NO. 6.—PAYING PRICE FOR GRADE “A LARGE” (EXTRAS)
AT COUNTRY POINTS

	1928	1929	1930	1931	1932	1933	1934
January	43.0	40.5	53.5	29.0	20.0	21.4	25.0
February	39.0	43.0	45.0	26.0	21.6	18.0	33.2
March	35.0	35.0	30.0	21.6	18.5	16.1	23.4
April	29.5	27.0	28.0	19.0	13.6	13.5	16.5
May	31.0	28.0	29.5	16.0	13.5	13.0	17.0
June	32.0	28.0	35.0	16.5	15.4	14.8	18.1
July	35.0	29.0	28.0	17.0	16.4	15.9	18.7
August	39.0	40.0	30.0	22.0	18.8	16.8	19.8
September	41.5	43.0	33.0	23.5	23.2	21.2	25.2
October	47.0	47.0	40.0	36.0	29.4	30.1	31.5
November	57.0	56.5	51.0	43.0	39.1	39.0	35.4
December	55.0	57.0	48.0	36.0	30.7	30.7	28.8
Average price per doz.	40.6	39.5	38.4	24.6	21.7	20.9	24.4

On the basis of the above prices and the average production figures as given in Tables 4 and 5 it will be found that there is considerable variation in the total value of the eggs laid by the different groups. The production figures would indicate that there would be little difference in the value of the eggs produced by either breed hatched in March or April.

The great difference is noticeable when comparing May hatched birds with either of the other groups. The March and April hatched Barred Rock pullets laid more eggs during the year and also laid more heavily during the months when eggs were a high price than did those hatched in May. On the contrary, the May hatched White Leghorns laid more eggs for the year, and as many if not more, during the months of November to February, than did the March and April hatched groups. It is difficult to figure the exact differences from the above tables as the grade of these eggs are not available and much would depend on how the eggs graded. The earlier hatched pullets would be expected to lay larger eggs earlier in the year and consequently their eggs would grade better and so would bring a higher price than would the eggs laid by the later hatched birds.

The above table also shows clearly the decided drop in egg prices in 1932 and 1933 compared with the four previous years during which prices were fairly stationary. A study of the table will, however, show that the relative values per month in 1932 and 1933, as compared with the previous four years, are practically the same. The prices gradually rise from May until they reach a peak in November and December and they fall to the year's low in April and May.

In presenting the foregoing figures it is not the intention that they be interpreted as possibilities of the two breeds, as the strain or selection work might show as great difference between strains of the same breed. These figures are given in the hope that they may suggest, particularly to the specialized poultryman, the necessity of carefully recording his daily, weekly, and monthly records of production costs and profits. The keeping of poultry as a specialized business means, if success is to be obtained, a daily or at least a weekly record of the loss and profit. Success or failure depends much upon these accounts. Yearly statements usually show losses, leaks, etc., too late.

FALL CARE OF BREEDING HENS

Birds to be considered as next year's breeders may be put out on a good grass range, or where there is a good patch of rape. The colony houses that were used for raising chickens may be moved to this range. The hens then are transferred to these houses, about fifty hens to a house, each house having a floor space of eight feet by twelve feet. This provides roosting space only. No mash feed is given nor any milk or animal protein. The birds are given a ration of whole grain, water and green feed, and allowed to range as they please. In a few days egg production ceases, the birds start to moult, the yellow returns to their legs and beaks, and they have a real holiday. There are enough birds in a house to keep it moderately comfortable on rainy or cold days, though it is possible that a few hens may be lost owing to a lack of physical fitness.

Our method is to allow these hens to remain on range for at least two months, after which they are placed in the breeding pens.

One usually has some very old, high-class breeding hens that have demonstrated their worth as breeders. Old hens often are late in starting to lay and frequently the first three or four eggs laid after a period

of rest are infertile. Because it is desirable to secure as many chicks as possible during March and April from these selected birds, it is our practice to use a little artificial light on them so that they may be laying a high percentage of eggs during February. They are fed the same ration as that fed to the pullets, using milk as the protein source, and care being taken that they have plenty of clover and bone meal. The birds are allowed out of doors when the weather permits and receive what direct sunshine is available. They also have two per cent of cod liver oil added to their mash mixture.

The Department has used the above plan with satisfactory results for the past eight years on upwards of a thousand breeders.

Hatchability of eggs is an inherited factor that is influenced by environment. Some hens' eggs are low in hatchability; others are high in hatchability. The above methods of feeding and management have given good results regardless of the number of eggs the hen may have laid during her pullet year.

FALL CARE OF PULLETS

After moving pullets in off the range to their Winter quarters, one should continue to feed the same ration as used on the range, for two or three weeks. Give the birds all the succulent green feed they will consume. If succulent material such as cabbage, rape, roots, lawn clippings or sprouted grains are not available, then the addition of a cup of molasses to each pail of drinking water would help. The sudden change from open range to confinement and all dry feed, tends to cause constipation, which condition conduces to the more ready development of disease. Do not be in too much of a hurry to push the pullets into heavy egg production. Give the birds a chance to get adjusted to the change of environment and its effect upon their physical condition. Do not overcrowd.

EXPERIMENTAL STUDIES OF THE PRODUCTION AND HATCHABILITY OF HENS' EGGS

Many thousands of dollars are lost annually because of poor hatches. Even in our modern types of incubators, with their efficient control for the regulation of temperature, ventilation and moisture, about forty per cent of the eggs set each Spring fail to hatch. Poor hatches may be attributed to many causes. Too often, however, such poor hatches are blamed on the incubator when in reality the fault lies elsewhere. It can be truthfully stated that the majority of incubators in use at the present time will give reasonably good results, provided the eggs set are from a well managed flock and provided the operator is faithful and accurate in his or her care of the machine.

Good management of the breeding stock is a very important factor in securing good hatches. This involves the selection of the birds used, not only as to their pedigrees and type, but also as to their health and vigour. Two other factors, the importance of which in reference to their influence on hatchability are not so generally recognized, are the ration fed to the breeders and the amount of sunshine to which these breeders

are given access. It is generally recognized by poultrymen that eggs set during the early part of the hatching season from birds in confinement do not hatch as well as do eggs produced later in the season by birds allowed outdoors and given plenty of sunshine. It was believed by the authors that the source of animal protein has a definite bearing on the value of a ration used for the production of hatching eggs, and it was desired to ascertain more exactly, if possible, the role of sunshine and of its commonly used substitutes in this respect.

In order to gather data on the effect of these factors, viz., the source of animal protein in the ration and sunshine and its substitutes, the experimental trials here reported were conducted. It was hoped that by such trials some measure of the actual effect of these proteins and of sunshine and its substitutes on hatchability would be secured.

The general plan of the experiment was to study the influence of such animal proteins as milk, fish meal, meat meal and tankage as they might affect hatchability and egg production. These materials were fed both singly and in combination as the sole source of animal protein in the rations, with and without cod liver oil. The experiments consider two main points:

1. The effect of certain animal proteins on the hatchability of hens' eggs;
2. The effect of the amount and quality of sunshine on the hatchability of hens' eggs.

Genetics is also a factor in hatchability and may be of equal importance with animal proteins and the amount and quality of sunshine. This factor is, however, not taken into consideration in the discussion of the results here reported. The birds used in the experimental trial were all of known ancestry and came from the general pedigree pens of the Department. Their ancestry was known for ten years or more, together with their record of performance. This information may help materially in the final study of the problem.

The incubator used was a six thousand egg Petersime machine, which made it possible to set all eggs daily over the entire period. This was done and so insured that all eggs would be under the same environmental conditions during incubation.

Twenty Barred Rock pullets and one male as nearly similar in age and breeding as possible were used in each pen. The males were moved from pen to pen daily in rotation. The results from all pullets used in the experiments conducted by this Department suggest that April hatched Barred Rocks give a lower hatch than birds hatched in February and March. Pullets were used in preference to hens because their eggs were likely to be a little more difficult to hatch, other things being equal.

In case of the death of a bird it was immediately replaced by a bird of similar breeding so that the pens were constantly up to strength.

The individual pens were twelve feet wide and twelve feet deep. There were two glass windows three feet by three feet six inches in each pen, as well as two movable screens which could be opened on days when the weather permitted. The screens were twenty inches square. One was covered with cheesecloth and the other with cel-o-glass. The trap-nests, drinking fountains, pens and feed hoppers were the same size in each pen. There should be little or no difference between the pens.

THE METHOD OF FEEDING AND MANAGEMENT

In view of the many factors that may affect both production and hatchability, a system of feeding and management was developed to control as many of these as possible. With this in mind, on a measurable basis, the following feed schedule was followed:

A.M.—A light feed of grain was scattered in the litter;

Noon—A portion of the mash for each pen was fed moistened;
The cod liver oil was fed in this mash daily;

P.M.—A heavy feed of grain was fed in troughs.

N.B.—No artificial lights were used.

The mash for each pen was fed in hoppers and was available for the birds to eat throughout the entire day.

All birds were confined to the pens for the entire eleven months.

RATIONS FOR EXPERIMENTAL HENS

Basal Mash to all pens:
700 lbs. corn chop
500 " wheat shorts
300 " oat chop
10% alfalfa meal
2½% bone meal
2% salt

Whole Grain Mixture:
50 lbs. cracked yellow corn
50 " wheat

Daily amount to each pen:
A.M.—½ lb. in the litter
P.M.—2 " in the hopper

To the dry mash, kept in front of the birds all the time, was added the following:

Pen.	Amount and kind of Protein	Other Additions
2	10% B.P. (Buttermilk Powder)	U.V.L. (Irradiation)
4	10% B.P.	Cod Liver Oil
6	5% B.P. + 7½% Fish Meal	
8	5% B.P. + 7½% Fish Meal	Cod Liver Oil
10	5% B.P. + 10% Meat Meal	Cod Liver Oil
12	5% B.P. + 10% Tankage	Cod Liver Oil
18	20% Meat Meal	Cod Liver Oil
20	10% B.P.	
22	20% Meat Meal	
24	20% Tankage	
26	15% Fish Meal	
28	15% Fish Meal	Cod Liver Oil
30	20% Tankage	Cod Liver Oil
32	37% B.P.	Cod Liver Oil

N.B.—U.V.L. (Ultra Violet Light) one-half hour of irradiation daily except Sunday.

C.L.O. (Cod Liver Oil) 20 c.c. daily to each pen, in moist mash.

In addition to the dry mash the birds had free access to oyster shell, grit and water at all times. The weighed quantity of grain, 2½ lbs. per pen per day, was fed on an assumed ratio of 50-50 mash to grain consumption. Any variation in food consumption was thus measured by the amount of dry mash and oyster shell eaten.

The protein supplements, with the exception of buttermilk powder, were added to the basal mash on an equivalent basis. Some quantities of the basal mash were weighed out weekly into separate containers

and the different animal proteins added to the various mixtures.

A chemical analysis of each individual source of protein was determined. An equivalent quantity of fish meal, meat meal and tankage was fed on the basis of their chemical analysis, with the exception of buttermilk powder, of which one-half of the quantity by weight was used.

The feeding trials included two pens for which buttermilk powder constituted the protein supplement in the mash. For the one pen 10% was added to the mash, while for the other 37% was added, this latter being enough to equal the amount of animal protein given to the pens fed fish meal and meat meal.

COMPOSITION OF THE RATIONS

In Table 7 is shown the percentage composition of representative samples of each of the protein supplements used in these experiments. Repeated analysis of different samples of the same protein concentrate, showed that the composition varied within fairly wide limits. For example, the buttermilk powder consignments analyzed varied in crude protein content from 29% to 35% it was, therefore, necessary to make protein demonstrations on each new batch of feed and to increase or decrease the amount of the protein supplement in the ration, so that the total protein would be kept approximately the same throughout the entire experiment. The percentage composition of the mash fed to each pen is given in Table 8 and was calculated from the percentage composition of the ingredients of the mash (see Table 7). To study the effect of adding cod liver oil or ultra violet irradiation to the buttermilk powder rations, the total protein of these rations was kept approximately the same at 13.5% (i.e., Pens 2, 4 and 20). The total protein content of the rations, planned to compare the different protein supplements both with and without cod liver oil (i.e., Pens 18, 22, 24, 26, 28, 30, and 32), was approximately 21%. Where comparing the nutritional value of the combinations of these protein supplements (i.e., Pens 6, 8, 10 and 12) the total protein of the rations was approximately 18%.

TABLE NO. 7.—PERCENTAGE COMPOSITION OF PROTEIN SUPPLEMENTS

	Meat Meal	Tankage	Fish Meal	Buttermilk Powder	Semi-Solid Buttermilk	Basal Mash
Moisture	3.84	5.89	5.90	7.62	71.25	9.82
Crude Protein (Nx6.25)	55.90	56.70	75.77	34.80	9.90	12.34
Ether Extract	14.58	10.91	3.86	5.31	1.65	4.78
Crude Fibre	1.22	1.79	.23	....	....	7.59
Lactose .....	....	....	....	37.91	10.90	....
Lactic Acid .....	....	....	....	5.82	4.60	....
Total Ash	10.51	20.28	17.63	8.47	1.90	4.95

TABLE NO. 8.—PERCENTAGE COMPOSITION OF THE MASH

Pen	Ration	Crude Protein (Nx6.25)	Ether Extract	Crude Fibre	Total Ash
2	B.P. + Irradiation	13.5	4.7	6.8	5.3
4	10% B.P. + C.L.O.	13.5	6.7	6.7	5.2
20	10% B.P.	13.6	4.7	6.8	5.3
32	37% B.P. + C.L.O.	20.6	6.9	4.6	6.2
18	20% Meat Meal + C.L.O.	20.8	8.7	6.1	7.8
28	15% Fish Meal + C.L.O.	21.3	6.4	6.3	6.7
30	20% Tankage + C.L.O.	21.1	8.0	6.7	8.1
26	15% Fish Meal	20.6	4.2	5.7	6.4
22	20% Meat Meal	21.0	6.7	6.3	7.9
24	20% Tankage	21.2	6.0	6.4	8.0
10	5% B.P. + 10% Meat Meal + C.L.O.	17.6	7.5	6.4	5.5
8	5% B.P. + 7½% Fish Meal + C.L.O.	17.9	6.6	6.5	6.0
12	5% B.P. + 10% Tankage + C.L.O...	17.6	7.2	6.5	6.5
6	5% B.P. + 7½% Fish Meal	18.2	4.7	6.7	6.2

The data referring to the hatchability of eggs is based only upon the fertile eggs. All the eggs candled out as infertiles during incubation were broken for examination. A small percentage of the eggs removed as infertile, at the time of candling, contained a dead germ of early development.

EMBRYO MORTALITY

The Distribution and Causes of Dead Germs

There appears to be three distinct peaks in embryo mortality during the incubation period, as shown in Fig. 1. The first peak appears between the second and fifth days and represents the dead germs removed on a first test, where it is made at the end of the first week. The second peak occurs from the ninth to the fourteenth days and the dead embryo would be removed at the second test, on the seventeenth or eighteenth days. The third peak, occurring after the eighteenth day, would constitute the fully formed dead-in-shell, at the end of the hatch.

DISTRIBUTION OF EMBRYONIC MORTALITY

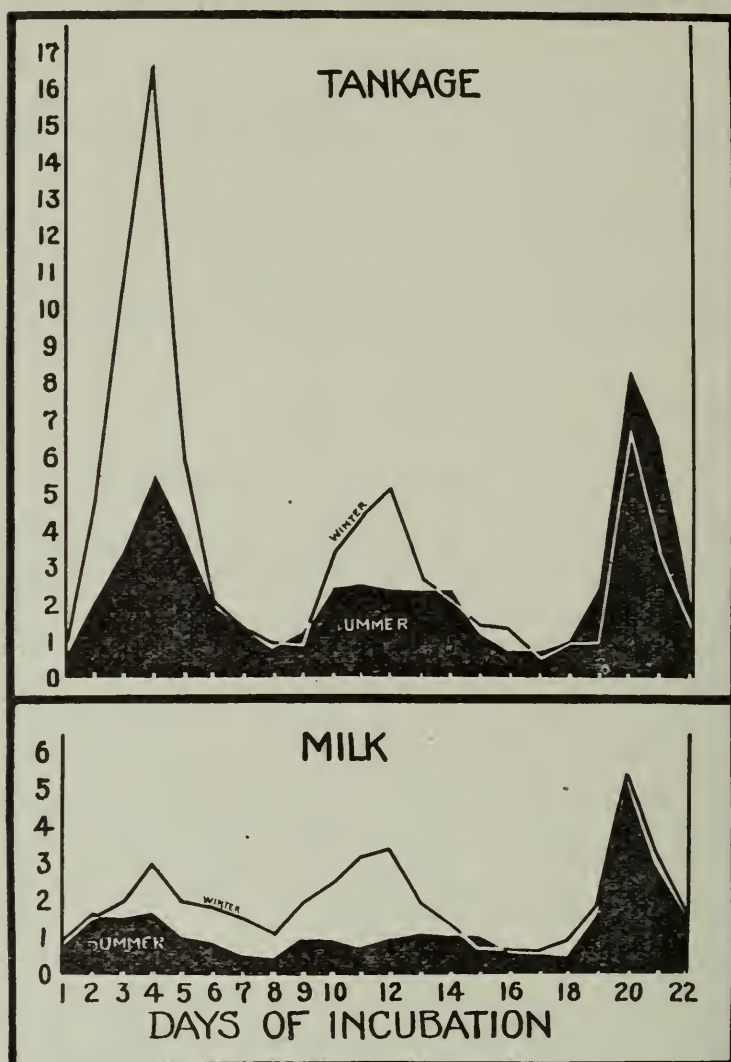


Fig. 1. Showing the distribution of embryonic mortality throughout the incubation period under both Winter and Summer conditions on two animal protein sources in the diet—top, tankage; bottom, milk. The birds were confined but received the available sunshine directly through wire-screened openings on the front of the pens.

The first two mortality peaks are quite definitely associated with the bird's nutrition and its freedom from disease, as is very clearly shown in Figs. 1, 3, 4, and 6. The third or last peak is not affected to the same extent by these factors. Seasonal variation is most marked, as between Winter and Summer, possibly due to the low antirachitic value of Winter sunshine and an insufficient supply of cod liver oil, or other D vitamin carriers.

In Fig. 1 is shown the hatchability results from tankage as a source of animal protein of low Winter value, and from milk as a source of high hatching quality.

The three mortality peaks are quite marked for tankage in the Winter graph. However, under Summer conditions, with increasing amounts of sunshine, these peaks were considerably reduced, as shown in the Summer graph, or the first peak was reduced from almost seventeen per cent to about five per cent. This same result is evident in the tests of milk, as shown in Fig. 6, but not to so marked an extent. In these latter the Winter peaks of mortality were not so high; in other words, this protein was more efficient in producing hatchable eggs in Winter than was tankage. It will of course be noted that there is at the same time considerable variation in the efficiency of the other proteins studied as affecting hatchability.

Likewise in Fig. 6, on the right hand side, is shown the results of the effect of a disease outbreak such as Laryngotracheitis. While not sufficiently severe to cause any mortality, it nevertheless very seriously lowered hatchability, as will be seen from a comparison with the results of a three year average on the same diets, as shown on the left hand side of the same figure. Similar results are shown in Figs. 3, 4 and 5.

SUNSHINE AS A FACTOR IN HATCHABILITY

The role of direct sunshine in the welfare of man, plants and animals is recognized, but perhaps not too well understood. Its influence on hatchability has been a matter of study for some time.

The amount of sunshine differs greatly between February and July.

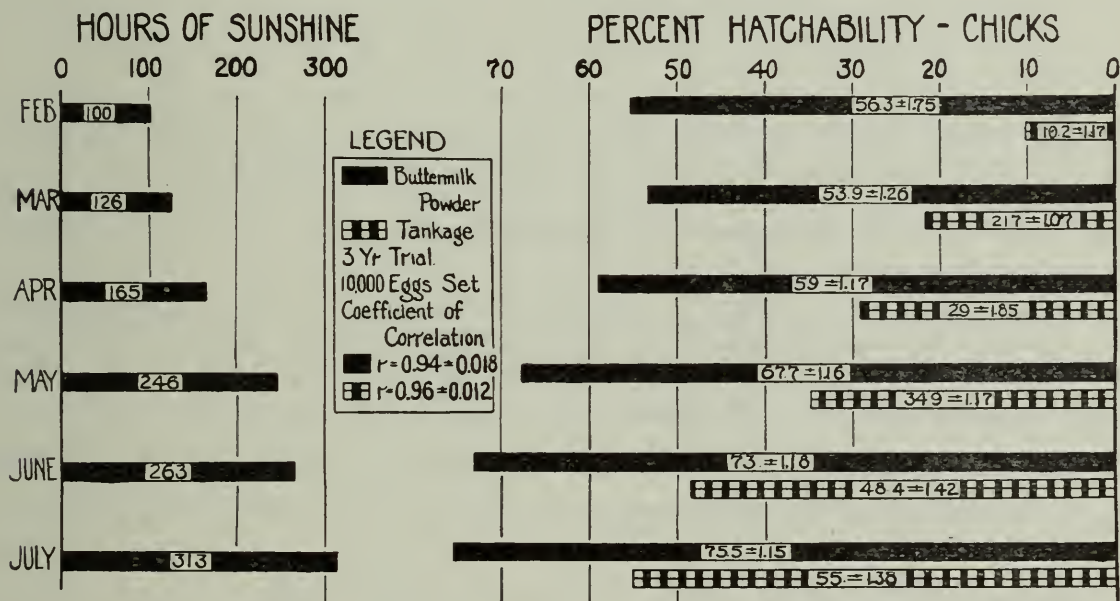


Fig. 2. Showing the influence of the amount of sunshine on the per cent of hatchability when two sources of animal protein, each differing widely in its feeding value, are used in the diet.

The antirachitic effect of sunshine during the months of April, May, June, July and August is approximately eight times as great as that of November and December (Tisdall and Brown). The beneficial results on hatchability from increased amounts of sunshine are clearly shown in Fig. 2, where two sources of animal protein, each differing widely in its feeding value, were used in the diet. The birds were confined to their pens, receiving the available sunshine through two openings twenty inches square. These openings were screened with cotton at night and on stormy days.

The results are based on a three year trial with over ten thousand eggs.

The high value of Summer sunshine naturally raises the question of a good substitute to compensate for the lack of it during the late Fall and Winter months; or could June and July hatches be duplicated in January, February and March with a suitable substitute?

THE INFLUENCE OF SUNSHINE ON EMBRYONIC MORTALITY

It is of importance to measure the influence of the amount of sunshine on the per cent and distribution of deaths during the twenty-one days required for incubation. The upper curve (Winter) represents the mortality curve in per cent of deaths of the fertile eggs set and is plotted against time in days of incubation, Fig. 1. The solid black area (Summer) represents the mortality rate in per cent of fertile eggs set. The Winter season includes the months of February, March and April, while the Summer is for that of May, June and July.

Tankage, (Fig. 1) has a low efficiency when used alone in the diet in the Winter months. There is a severe peak in mortality on the fourth day, reaching about seventeen per cent of the fertile eggs set. It will be seen that the peak is greatly reduced in the Summer, which naturally results in much higher hatchability. In Winter 15.1 per cent of the fertile eggs contained embryos which died on the fourth or fifth days in an anaemic condition. During the Summer the occurrence of anaemic embryos in the eggs from this diet declined to a 1.5 per cent average with few, if any, dying during the month of July from this abnormal condition.

Where milk (buttermilk powder) is used alone in the diet (Fig. 6) the increase in hatching quality of the eggs is due to a straightening out of the curve representing the first and second week mortality rate. The mid-incubation peak in the Winter mortality curve is reduced more through the beneficial action of increased amounts of direct sunshine than in the first week peak, occurring on the fourth day. Neither the diet fed the hen nor the season of the year appear to have any influence on the death rate taking place on the twentieth day. Malpositions play a part in this excessive mortality during artificial incubation but they will not be discussed at this point.

TABLE NO. 9.—SHOWING THE INFLUENCE OF THE AMOUNT AND QUALITY OF SUNSHINE ON THE PERCENTAGE HATCHABILITY

Ration	Feb.	Mar.	April	May	June	July
Buttermilk Powder	56.3	56.1	59.0	71.7	72.8	74.8
Meat Meal	51.2	47.4	44.6	55.0	68.6	63.6
Tankage	10.2	21.7	29.0	34.9	48.4	55.0

The beneficial influence of the amount and quality of sunshine is clearly shown in Table 9. With over two hundred hours of sunshine the hatch is increased 12.7 per cent, 10.4 per cent and 5.9 per cent for buttermilk powder, meat meal and tankage. The hatching quality of the eggs gathered in May, June and July has, for all three rations already referred to, been greatly improved over that for the months of February, March and April.

The following tables contain a summary of the three years' results for several rations differing mainly in the kind of animal protein used. In each table are given the results for a single animal protein alone and in combination with cod liver oil, and with the oil and another protein. The accompanying graphic illustrations present a picture of the embryonic mortality during the incubation period on some of these same feed combinations.

TABLE NO. 10—MEAT MEAL—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar	April	May	June	July	*Egg Production	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Meat Meal	51.2	47.4	44.6	55.0	68.6	63.6	138.4	7.05	80.9
Meat Meal and C.L.O.....	69.2	67.4	59.9	71.9	70.6	72.0	164.2	5.95	77.5
Meat Meal, Buttermilk Powder and C. L. O.	76.9	75.2	60.0	59.6	66.5	74.5	165.6	5.87	81.0

* Eleven months only.

A combination of buttermilk powder, meat meal and cod liver oil was a more satisfactory ration than either meat meal or meat meal and cod liver oil. When buttermilk powder and cod liver oil were added to meat meal, the egg production was increased thirty-seven eggs per hen, the hatchability of the eggs was much higher for the Winter months and

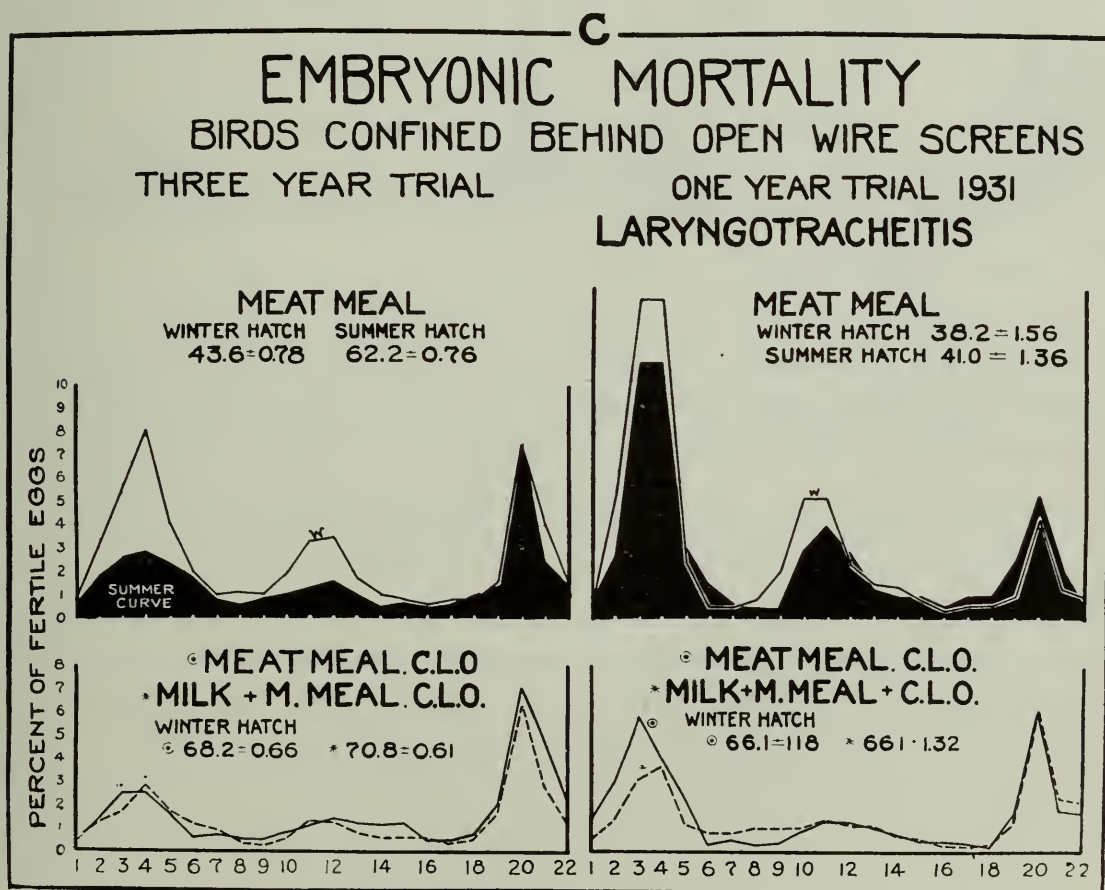


Fig. 3. Showing the effectiveness of cod liver oil when added to meat meal in promoting Winter hatchability. The milk, meat meal and cod liver oil combination gave a satisfactory Winter hatch. On the right hand side of the chart, the influence of the disease factor is shown, where the source of animal protein in the ration was meat meal.

over one pound of feed was saved for every dozen of eggs laid. The beneficial influence of cod liver oil when added to meat meal is shown by the increase in the number of eggs produced, the pounds of feed required to produce one dozen eggs, and the hatchability of the eggs for all the months but more especially for those of the Winter season. It is interesting to note that after two hundred hours of sunshine were available, the meat meal pen produced a much higher hatchability. A combination of animal protein supplements fed with cod liver oil gave more satisfactory results than did a single animal protein supplement with cod liver oil.

TABLE NO. 11.—FISH MEAL—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar	April	May	June	July	*Egg Produc- tion	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Fish Meal	57.4	59.3	53.0	56.6	69.4	71.8	165.4	6.18	85.1
Fish Meal and C.L.O.	64.3	60.2	50.3	63.6	66.4	67.5	177.8	5.64	83.6
Fish Meal, Buttermilk Powder and C. L. O.	79.2	74.0	58.8	63.3	67.9	67.9	166.6	5.91	82.0

* Eleven months only.

When cod liver oil was added to fish meal the egg production was increased one dozen eggs per hen for eleven months and it required less feed to produce a dozen eggs. Apparently the vitamin content, as supplemented by cod liver oil, has some influence on the egg production. Cod liver oil did not improve the hatch for February, March and April when added to fish meal to the same extent that it did when added to buttermilk powder or meat meal. With buttermilk powder and cod liver oil added to the fish meal the hatch was greatly improved for February and March and was somewhat higher for April. The egg production was eleven eggs less per hen where buttermilk powder was added to the fish meal and cod liver oil and it required slightly more feed to produce a dozen eggs.

While the egg production was down eleven eggs on the average for buttermilk powder, fish meal and cod liver oil, as compared with fish meal and cod liver oil, the hatchability of the eggs was very much in favour of the combination ration.

EMBRYONIC MORTALITY

THREE YEAR TRIAL
BIRDS CONFINED-OPEN WIRE SC

ONE YEAR TRIAL
LARYNGOTRACHEITIS PRESENT

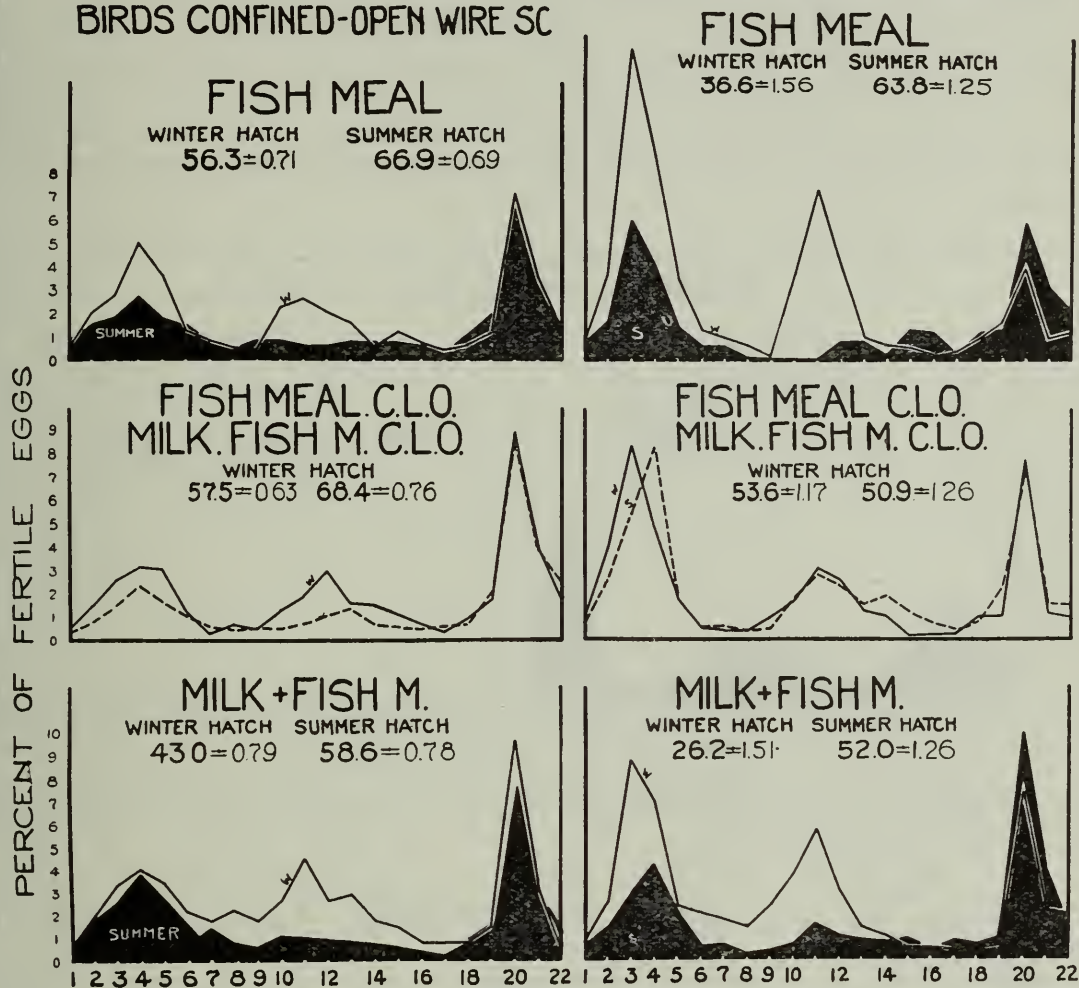


Fig. 4. On the right the effect of an infection on hatchability and embryonic mortality during the 1931 season is shown for the sake of comparison. On the upper left the failure of cod liver oil to improve the Winter hatch, when fish meal was the source of animal protein, is shown. Milk and fish meal when fed without cod liver oil gave unsatisfactory results. The value of milk on hatchability is indicated when the results for milk, fish meal and cod liver oil are compared with that of fish meal and cod liver oil.

TABLE 12.—TANKAGE—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar	April	May	June	July	*Egg Production	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Tankage	10.2	21.7	29.0	34.9	48.4	55.0	126.6	7.44	78.5
Tankage and C. L. O.	27.9	41.2	28.7	39.4	57.8	57.6	157.2	6.03	79.3
Tankage, Buttermilk Powder and C. L. O.	72.0	58.6	58.7	42.7	55.6	60.4	151.0	6.41	80.7

* Eleven months only.

Tankage gave a low egg production, eggs of poor hatchability, and it required over thirty per cent more feed to produce a dozen eggs than where fish scrap was used. Cod liver oil added to tankage increased egg production thirty-one eggs per hen with almost one and one-half pounds of feed less required to produce one dozen eggs. The hatching quality of the eggs was improved for all months but was still unsatisfactory. A combination of buttermilk powder, cod liver oil and tankage gave a fair hatch, but did not compare favourably with the results from the other combination rations studied. Not only did cod liver oil improve the hatchability of the eggs, when added to tankage, but it also materially increased the egg production.

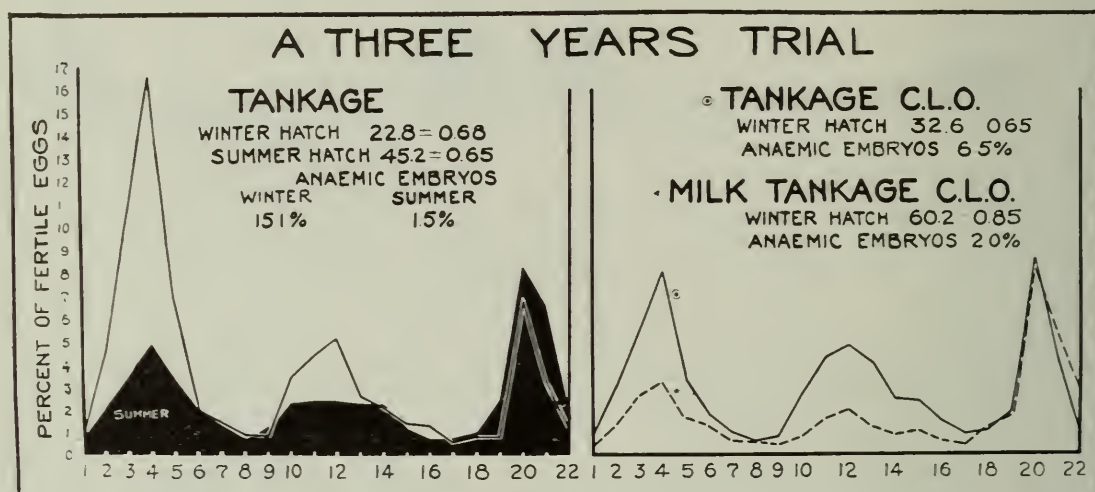


Fig. 5. The value of milk in the ration fed the breeders is shown graphically in the above chart.

TABLE NO. 13—MILK—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar	April	May	June	July	*Egg Production	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
10% Butter-milk Powder	56.3	56.1	59.0	71.7	72.8	74.8	143.6	7.05	84.4
10% Butter-milk Powder and C. L. O.	73.4	69.9	60.6	54.8	64.1	65.1	153.5	6.48	82.8
†37% Butter-milk Powder and C.L.O.....	75.8	75.7	65.8	74.1	80.0	73.3	153.7	6.07	77.8
‡10% Butter-milk Powder & Irradiation	74.1	77.2	71.7	74.0	79.5	77.1	139.8	7.01	81.7

* Eleven months only.

† Two year results.

‡ Birds handled every day except Sunday.

With the addition of cod liver oil to buttermilk powder the number of eggs produced was increased, the hatchability was improved considerably for the Winter months, and less feed was required to produce a dozen eggs. Again it may be seen that the amount of vitamin as supplied by cod liver oil, or as activated by irradiation, has not only influenced the hatchability of the eggs but also the egg production. By increasing the amount of buttermilk powder in the diet to thirty-seven per cent there was no increase in the egg production although a little feed was saved. The hatchability, however, was higher for all the months. Irradiation from a Mercury Quartz Lamp would appear to be more efficient in activating the development of the necessary vitamin D than was cod liver oil. The egg production for this pen was low, but in view of the fact that the birds were handled every day except Sunday and were carried in a crate to the top floor of the poultry building to be irradiated, introduced a point of difference when comparing this pen with the other pens. It would seem that when buttermilk powder is fed at the same level as meat meal, fish meal or tankage there is possibly a wastage of this material.

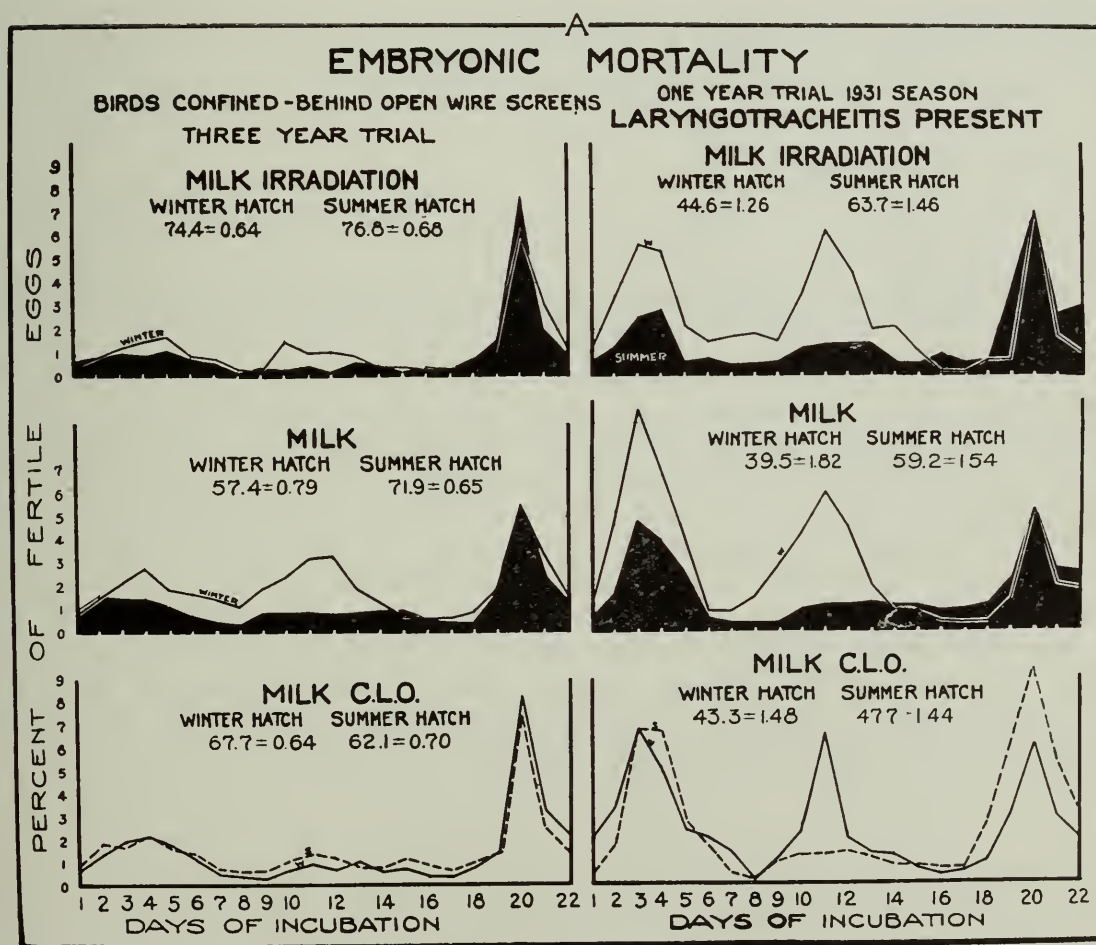


Fig. 6. Comparing the efficiency, when the source of animal protein was the same, of cod liver oil and irradiation of the birds. The effect on hatchability and embryonic mortality of a mild infection of Laryngotracheitis is clearly shown on the right hand side of the chart.

TABLE NO. 14.—A COMBINATION OF PROTEINS—PERCENTAGE
HATCHABILITY

Ration	Feb.	Mar	April	May	June	July	*Egg Produc- tion	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Buttermilk Powder and Fish Meal ...	58.2	49.1	30.9	42.6	64.5	68.1	141.4	6.78	79.9
Buttermilk Powder, Fish Meal and C. L. O.	79.2	74.0	58.8	63.3	67.9	67.4	166.6	5.91	82.0
Buttermilk Powder, Meat Meal and C. L. O.	76.9	75.2	60.0	59.6	66.5	74.5	165.6	5.87	81.0
Buttermilk Powder, Tankage and C. L. O.	72.0	58.6	58.7	42.7	55.6	60.4	151.0	6.41	80.7

* Eleven months only.

Many are of the opinion that heavy egg production tends to decrease the hatchability of eggs. This does not seem to be the case when the results from the two diets—buttermilk powder, fish meal and cod liver oil, and that from buttermilk powder, meat meal and cod liver oil—are considered. The average production for eleven months was 165 and 166 respectively, while the hatchability averaged over 70 per cent for the months of February, March and April. When tankage was used in place of either fish meal or meat meal, the egg production was down fourteen eggs per bird, more feed was required to produce a dozen eggs, and the hatchability of the eggs was decreased considerably. Twenty-five eggs more per hen were produced when cod liver oil was added to buttermilk powder and fish meal. Hence almost one pound of feed was saved for every twelve eggs produced, and the hatchability of the eggs was greatly increased for the more important hatching months.

A study of the three years' summary shown in Table No. 15 seems to justify the following conclusions:

- (1) When fish meal, buttermilk powder, meat meal and tankage are compared from the standpoint of their feeding value for the production of eggs they rank in the order named.

- (2) The addition of cod liver oil to a single animal protein supplement increased the egg production with all rations tested, but much more so with meat meal and tankage than with buttermilk powder and fish meal.
- (3) A combination of fish meal and buttermilk powder failed to increase either the hatchability of the eggs or the number of eggs produced.
- (4) Cod liver oil when added to a combination of buttermilk powder and fish meal, buttermilk powder and meat meal, or buttermilk powder and tankage, increased both hatchability and egg production.
- (5) Tankage does not appear to be a desirable source of animal protein when fed as the sole source, but when fed in combination with milk produces moderately good results.
- (6) The addition of direct sunshine or sunshine substitutes, such as a high grade of cod liver oil or irradiation by a Quartz Mercury Lamp, to the rations used, plus alfalfa meal, was the most important factor in producing eggs of high hatchability.
- (7) Vitamin D appears to be a very important factor in hatchability. The birds used in these feeding trials did not get the necessary amount of this factor until there were at least two hundred hours of sunlight per month.
- (8) Buttermilk powder with meat meal or with fish meal, together with cod liver oil, appears to be the most satisfactory combination of supplements used in these trials when hatchability, egg production and the pounds of feed required to produce a dozen eggs are considered.

THE EFFECT OF INFECTION ON PRODUCTION

Reference has already been made to the effect of Laryngotracheitis infection on hatchability, Figs. 3, 4, 5 and 6. In Table No. 16 are given the results of such an infection on production. The data for 1930-'31 shows a marked drop in the number of eggs laid over the ten months' period as compared with a similar period in 1931-'32 on the same diets. There is what appears to be an exception to this in the 27½ per cent milk and cod liver oil diet, which was used in 1930-'31 but not in the following year. In this particular case the birds appeared to react less severely to the infection than on any of the other rations. This may have been due to the greater laxative effect of the high milk diet, or the heavier intake of some dietary factor inhibiting the pathogenic action of the infective virus.

TABLE NO. 15.—SUMMARY OF THREE YEARS' RESULTS PERCENTAGE HATCHABILITY

RATION	Feb.	Mar.	April	May	June	July	*Egg Produc- tion	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird	Total Eggs set for three years
Buttermilk Powder, Meat Meal and C.L.O.....	76.9	75.2	60.0	59.6	66.5	74.5	165.6	5.87	81.0	5851
Buttermilk Powder, Fish Meal and C.L.O.....	79.2	74.0	58.8	63.3	67.9	67.4	166.6	5.91	82.0	5730
Buttermilk Powder and Irradiation	74.1	77.2	71.7	74.0	79.5	77.1	139.8	7.01	81.7	4732
10% Buttermilk Powder and C.L.O.	73.4	69.9	60.6	54.8	64.1	65.4	153.5	6.48	82.8	5430
37% Buttermilk Powder and C.L.O.	75.8	75.7	65.8	74.1	80.0	73.3	153.7	6.07	77.8	3682
Tankage and C.L.O.	72.0	58.6	58.7	42.7	55.6	60.4	151.0	6.41	80.7	5256
Buttermilk Powder, Meat Meal and C.L.O.	69.2	67.4	59.9	71.9	70.6	72.0	164.2	5.95	81.3	6103
Fish Meal and C.L.O.	64.3	60.2	50.3	63.6	66.4	67.5	177.8	5.64	83.6	6575
Fish Meal	57.4	59.3	53.0	56.6	69.4	71.8	165.4	6.18	85.1	5958
Buttermilk Powder	56.3	56.1	59.0	71.7	72.8	74.8	143.6	7.05	84.4	4985
Meat Meal	51.2	47.4	44.6	55.0	68.6	63.6	138.4	7.01	80.9	4683
Buttermilk Powder and Fish Meal	58.2	49.1	30.9	42.6	64.5	68.1	141.4	6.78	79.9	4630
Tankage and C.L.O.	27.9	41.2	28.7	39.4	57.8	57.6	157.2	6.35	79.3	5890
Tankage	10.2	21.7	29.0	34.9	48.4	55.0	126.6	7.44	78.5	4523

* Two years.

TABLE NO. 16.—EGG PRODUCTION RESULTS FROM VARIOUS PROTEINS FOR A TWO YEAR PERIOD

An outbreak of Laryngotracheitis in 1930-'31 shows in most cases a decided reaction on Production.

Ration	Egg Production 10 Months		Lbs. Feed To Produce Dozen Eggs		Average Feed Consumed per Bird	
	1930-'31	1931-'32	1930-'31	1931-'32	1930-'31	1931-'32
Milk, Meat, C.L.O. ...	127.6	148 5	6.1	5.9	65.7	73 6
Milk, Fish, C.L.O. ...	126.4	143.2	5.8	5.8	61.2	69.7
Milk, Irradiation	83.1	112.5	7.7	8.3	61.0	78.4
10% Milk	109.5	122.7	7.0	6.8	64.7	71 0
10% Milk, C.L.O.	110.2	141.1	6.8	6.1	62.8	71.5
Meat Meal	114.1	167.9	6.9	5.4	65.9	76.5
Meat Meal, C.L.O. ...	136.2	153.5	5.8	5.8	66.5	73 8
Fish	140.2	155.4	5.8	5.7	67.8	73.8
Fish, C.L.O.	143.1	156.7	5.4	5.5	64.5	71.5
Milk, Fish	97.4	101.8	7.2	8.0	58.3	68 0
37% Milk, C.L.O.	154.0	.....	5.0	...	65.0	....

SOME FURTHER PROTEIN STUDIES

In 1933 the basal 7-5-3 mash was replaced by the Cafeteria basal developed from the results of a free choice feeding experiment. This mash was made up as follows:

Cafeteria Basal Mash

400 lbs. ground yellow corn
100 " corn feed or yellow hominy
200 " white hominy feed
450 " rolled wheat
150 " wheat germ
50 " wheat bran
100 " rolled barley
300 " crushed oats
50 " Banner oat feed, or an equal amount of oat middlings
20 " ground peas
20 " soya bean oil meal
10 " iodized salt
1 pint cod liver oil to each hundred pounds of mash mixture.
Oyster shell, bone meal and grit supplied in hoppers.

Using the Cafeteria basal mash, further experiments were carried on with the animal proteins—milk, meat meal and fish meal, separately and in combinations.

The control (Cafeteria) ration, with the animal protein from three different sources, gave a 53.4 per cent hatch for a five month period, Fig. 7. Later, however, when the birds were turned out of doors on a good grass range the hatch improved almost immediately, with an average of 75.6 per cent. From a hatching standpoint the diet appeared to be deficient, such deficiency being supplied by range conditions. Using the same ration, but changing the source of animal protein to milk, a hatch of 74.5 per cent was obtained over a five month period. This is further evidence that milk supplies a factor or factors necessary for successful hatchability and is a reliable source of animal protein to use. Meat meal gave a low hatch of 38.3 per cent, while fish meal gave a hatch of 45.7

EMBRYONIC MORTALITY ONE YEAR RESULTS CAFETERIA BASAL MASH



Fig. 7. The influence on hatchability of the source of animal protein fed in the ration is clearly shown in the above chart. A comparison of the first and second weeks' mortality rates during incubation appears to be greatly influenced by the diet fed the hen.

per cent. A marked improvement in hatchability under range conditions was shown by these proteins with a 61.1 and 66.4 per cent hatch, respectively.

There is a striking difference in the first and second weeks' death rates during incubation between the milk diet and the others. Excessive embryonic mortality occurred during the first and second weeks of incubation when the diet fed was the control, meat meal or fish meal.

To determine, if possible, the nature of the deficiency of such diets as the control, meat meal and fish meal, liver extract was fed to four pens

EMBRYONIC MORTALITY LIVER EXTRACT OR MILK - IS A FACTOR IN WINTER HATCHABILITY

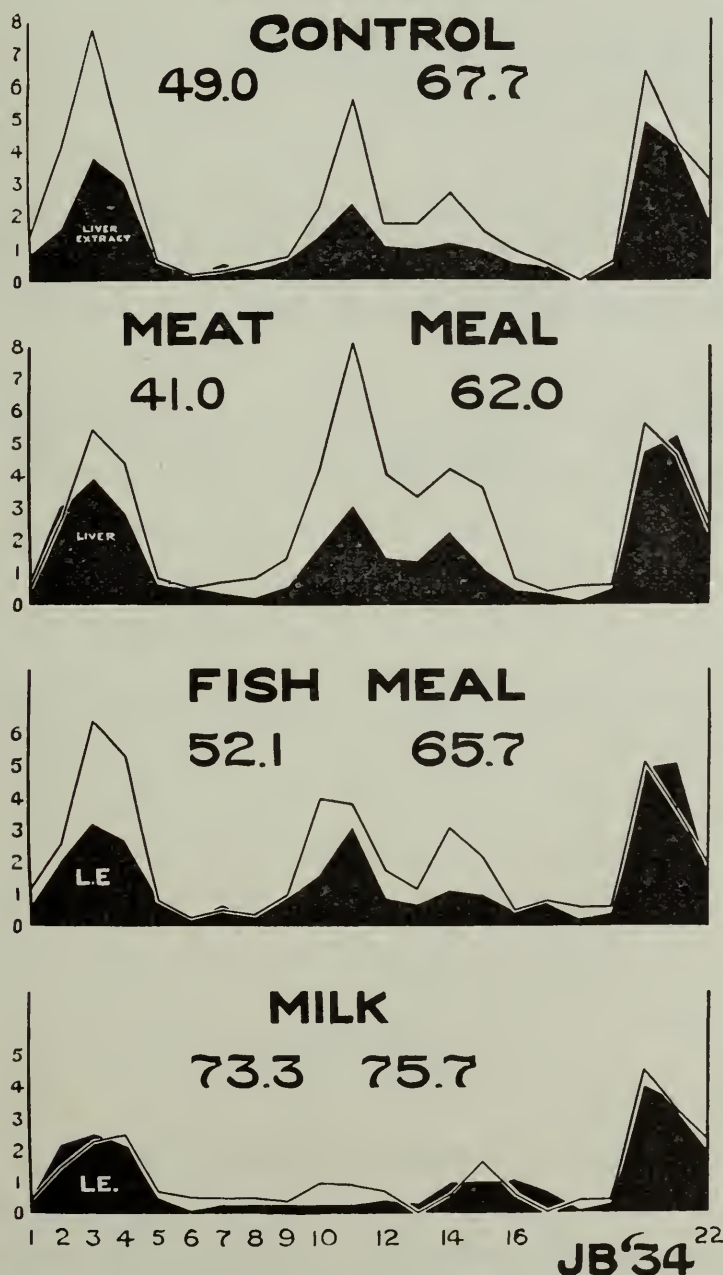


Fig. 8. Showing the results in hatchability and the distribution of embryonic mortality of four different diets with and without the addition of liver extract.

during the season of 1934. (This latter material was kindly supplied to us by the Connaught Laboratories in Toronto.) It is described by them as follows: "The liver extract, while free from protein nitrogen, did contain nitrogen in peptides or relatively simple compounds." By feeding a small amount of this material to four pens of birds on four different animal protein diets, Fig. 8, the improvement in hatchability is worthy of note with the exception of where milk was the source of animal protein. Those pens receiving the same ration, but having liver extract added, gave satisfactory hatches. Apparently a well marked deficiency from a hatching standpoint in the control, meat meal and fish meal diets, was supplied through the use of this material. It is interesting to compare the results in hatchability of the milk diet with those of the milk and liver diet. Here there was little, if any, significant difference in hatchability, which points strongly to the fact that milk contains the factor or factors necessary for a successful hatch.

Liver extract reduced the first and second weeks' mortality rates during incubation, which were excessive for the control, meat meal and fish meal diets. The source of animal protein fed in the diet appears to have a very definite influence on the per cent and periodicity of deaths during the first eighteen days of incubation.

The results in egg production for 1932-'33 and 1933-'34 on the Cafeteria basal ration, with the various proteins, are shown in Table No. 17. Soya bean oil meal, with and without milk, also crab scrap, were here tested in addition to the other protein sources—milk, fish meal and meat meal—and the production results are given.

TABLE NO. 17.—EGG PRODUCTION ON CAFETERIA BASAL MASH
PLUS VARIOUS PROTEIN SUPPLEMENTS

Ration	Egg Production		Lbs. Feed To Produce Dozen Eggs		Average Feed Consumed per Bird	
	1932-'33	1933-'34	1932-'33	1933-'34	1932-'33	1933-'34
Cafeteria	170.1	154.1	5.3	5.3	75.1	68.6
Milk	184.4	179.2	5.3	5.2	80.5	75.0
Meat Meal	155.4	142.5	5.5	5.9	71.2	70.5
Fish Meal	182.3	172.4	5.3	5.2	79.5	75.5
Milk and Soya Bean Oil Meal .....	.....	146.0	...	5.9	....	72.0
Soya Bean Oil Meal	153.1	.....	6.1	...	78.1	....
Crab Meal .....	.....	153.5	...	6.2	....	80.0

In view of the rather interesting results in hatchability obtained with the addition of liver extract, as shown in Fig. 8, the egg production results on these same diets are given in Table No. 18.

TABLE NO. 18.—EGG PRODUCTION ON CAFETERIA BASAL MASH,
PLUS PROTEINS, PLUS LIVER EXTRACT

Ration	Egg Production	Lbs. Feed Consumed to Produce Doz. Eggs	Average Amount Feed Consumed per Bird
Cafeteria and Liver Extract	176.3	5.5	80.6
Meat and Liver Extract	135.6	6.2	71.4
Fish and Liver Extract	187.9	5.2	81.0
Milk and Liver Extract	167.6	5.3	74.3

Some experimental work has been carried on with the four cereal grains—corn, wheat, oats and barley—ground and fed in equal parts. Three different percentage levels of meat meal and fish meal were fed with the cereals. The egg production results are given in Table No. 19.

TABLE NO. 19.—GROUND CORN, WHEAT, OATS AND BARLEY,
EQUAL PARTS, PLUS ANIMAL PROTEINS AS SHOWN

Ration	Egg Production 1932-'33	Lbs. Feed Consumed to Produce Doz. Eggs	Average Amount Feed Consumed per Bird
7% Meat	143.1	5.8	69.1
10% Meat	151.2	5.9	74.0
19% Meat	178.7	5.1	76.2
5¼% Fish	155.1	5.5	71.2
10% Fish	162.1	5.6	76.3
13% Fish	192.5	4.7	75.6

INCUBATION

The number of eggs needed to produce a chick influences the cost materially. The factors that may influence the hatch are many, including the maturity, age, and breeding of the parent stock and the kind and method of feeding. The method of incubation and the type of incubator, including the operator and the room used for incubation are also important factors.

With many factors influencing the results, the cause or causes of failure are difficult to locate and, furthermore, many of these problems are not easy to investigate.

The operator must be painstaking, accurate and methodical in his habits. The management of a large number of setting hens, or the operation of incubators, requires careful attention at regular intervals. Because an incubator is equipped with a regulator does not mean that the machine will take care of all possible variations in temperature, nor will a heater produce the required units of heat without fuel. The operator must realize that he must do his part.

The room in which the incubators are operated must be well ventilated without producing direct draughts over the machines. The air of the incubator room should be as pure as that in a living room. The less variation in temperature within the room the easier the machine will operate. Any well ventilated, CLEAN cellar or living room will answer.

Machines as a rule run better when set along a wall or in a corner of the room. They should not be set in direct line between an open door and a window. If so placed, unless screened, the lamp may go out or the machine may heat unevenly.

Machines for hatching, varying in capacity from fifty eggs to forty thousand eggs, are now sold. The larger sized machines are gradually replacing the smaller ones. The reasons are clear, in that the larger machines are more economical with labour and fuel. The general trend is towards central hatching stations where one may have eggs hatched at a given price per egg or where one may buy day-old chicks. Many find incubating eggs a good business, while others prefer to go to a hatchery to get their year's supply of chicks without worrying over setting hens or small lamp incubators.

Many makes of incubators have been used at this Department and most of them will give good results if carefully managed. We have seen no one incubator that excelled all others.

Cleaning and Disinfecting Incubators

Cleaning: Thoroughly clean out the machine, scraping from the inside, bottom and sides any adhering dirt. Scrub the interior with hot water which may be added Gillett's Lye, one tablespoonful to a gallon of water, or one of the common coal tar disinfectants in the recommended strength. When the machine and trays have been thoroughly cleaned in this way, they are ready for disinfection.

Methods of Disinfection

Liquid: Thoroughly saturate the interior of the machine with any

liquid disinfectant. The strength of the solution varies with the brand used but one should be careful to see that the solution used is well up to strength.

Gas: . In case one does not wish to use a liquid disinfectant, Formaldehyde Gas may be used. Its application is easy and efficient when properly applied. For this use 1 gram Potassium Permanganate crystals to 1.5 cubic centimeters of Commercial Formalin to each cubic foot of space in the machine. To apply, prepare the required quantities of the two drugs for your machine. Place the Potassium Permanganate in a wide, flat, enamelled vessel in the bottom of the machine, as the material will boil and spatter when the Formalin is added. When all is ready, add the required quantity of Formalin solution from an open topped container, as this must be done quickly. As soon as the Formalin is added close up the machine. Leave the machine closed for at least fifteen minutes, after which time open the doors and allow the gas to escape.

For most effective results the machine must be warm and the humidity on the wet bulb thermometer 85 degrees or better 90 degrees. Eggs may be gassed in the machine at any time EXCEPT FROM THE 24TH TO THE 84TH HOURS OF INCUBATION; or in other words, eggs may be gassed during the first 24 hours after setting. Otherwise they must not be exposed to the above concentration of gas until after they have been in the incubator 3½ days.

Frequency of Disinfection: Machines should be disinfected after each hatch. This, where properly done, prevents any accumulation of infection from one hatch to another. WE DO NOT ADVISE GASSING CHICKS.

Operating an Incubator

Given a suitable room, the first thing is to see that the machine is thoroughly cleaned. The next operation is to set the machine level. The thermometer must be accurate, and to assure accuracy it should be tested at least once, or better, twice, during the year by having it checked with a clinical thermometer. The temperature given is usually one hundred and three degrees Fahrenheit throughout the hatch. Our experience has been that it is better to take an objective of one hundred and one to one hundred and two degrees and if the temperature creeps up to one hundred and three degrees we have no cause to worry. If operated at a temperature of one hundred and three degrees and the temperature rises to one hundred and four or above either the hatch is small or the chicks hatched are hard to rear. Low temperatures are not so fatal as are high temperatures.

The amount of moisture required in an incubator depends upon the make and the room. Generally it is best to follow the manufacturer's directions.

Cooling and Turning: Eggs incubated in cabinet type incubators are turned by the use of mechanical turners and are not cooled. A forced draft ventilation supplies plenty of oxygen for best results and frequent

turning of the eggs stimulates the interchange of oxygen for carbon-dioxide given off by the developing embryo. The CO_2 is then removed by the ventilation. It is not necessary to hold as high temperature in such a machine as it is in a deck type incubator. If one did, the chicks would hatch before the 21st day. Cabinet type incubators hatch well when operated at 99.5 degrees to 100 degrees F., although the correct temperature depends much on the percentage humidity in the machine.

It is not necessary to cool eggs in a farm or deck type incubator if it has a good ventilation system. Cooling retards development of the embryo by lowering the temperature of the eggs below the optimum for growth. While cooling encourages the interchange of carbon-dioxide within the egg for oxygen in the outside air, frequent turning of the eggs inside a well ventilated machine will secure just as satisfactory results in this respect without cooling. Where eggs are regularly cooled, it is necessary to operate the incubator at a temperature of from 102 degrees to 103 degrees F. in order to have the chicks hatch on time. A temperature of 101 degrees F. during the first week, 102 degrees during the second week and $102\frac{1}{2}$ to 103 degrees during the third week of incubation will hatch the chicks on time when no cooling is done. Most modern incubators are well ventilated and sufficient additional airing of the eggs is secured during the time the eggs are removed from the machine for turning. If the temperature should accidentally rise too high, the tray should be removed and set on top of the machine and the eggs allowed to cool for a short time. The incubator door should be kept closed while turning the eggs in order that the eggs when returned to the inside will return to hatching temperature quickly.

The eggs should be turned at least twice each day, commencing on the third day, although in cabinet machines they are turned from the time they are put into the incubator. Turning prevents the embryo from adhering to the shell membrane and also exercises the embryo. Three or four turnings per day will increase the percentage hatch from 2 to 5 per cent above that secured where only two turnings are given. Machines with mechanical turning devices allow eggs to be turned easily and quickly. When eggs must be turned by hand the value of the time involved in giving more than two turnings per day may offset any improved hatch secured. Turning is discontinued on the eighteenth day. It should be remembered that eggs should be turned fairly gently, as rough handling is detrimental to the production of a good hatch.

It is wise to follow the manufacturer's instructions until such time as experience indicates suitable changes for the operator's particular conditions.

Hatching by the Natural Method

Setting the Hen: It is generally agreed that, in order to secure a good hatch, the hen must be placed where other hens are not likely to disturb her, for, as a rule, we seldom get good hatches when other hens lay in the nest with the setter. Some farmers do not set a hen until one becomes broody on a nest where no others lay. Such a practice often

results in the production of late hatched chicks. The difficulty can be overcome by making a new nest for the broody hen. For this purpose one may use a box about twelve inches square and six inches deep. Place some earth or an overturned sod in the bottom, being careful to have the corners very full so that no eggs can roll out from under the hens and become chilled. Place about two inches of straw or chaff on top of the earth and shape it to the form of the nest, then place in it a few nest eggs or cull eggs for the hen to set on. The hen should be set in some pen where nothing will disturb her. She will usually set better if moved to the nest after dark. Feed and water must be within easy reach, and a dust bath should also be convenient. If on the following day the hen is setting quietly you will be safe in putting the eggs under her. We get ninety per cent of the hens to set by the use of this method. The hen should be dusted with Sodium Fluoride or some other good insect powder when set, and also a few days before the hatch comes off. This treatment will control body lice and, therefore, keep the hen more comfortable.

Selection of Eggs for Hatching

Select for size, shape and colour. In view of the weight standards for market eggs, it is wise to select eggs for hatching which are two ounces or better in weight. It is well to keep in mind that two-ounce pullet eggs are equal to a somewhat heavier egg from the same bird as a hen. Continuous selection, year after year, will give results. Do not select dirty eggs nor handle eggs with soiled hands. The egg shell is porous, hence there is a possibility of contamination.

Eggs deteriorate in hatching quality with age. When holding eggs for hatching, keep them in a cool place at about fifty to sixty degrees Fahrenheit. The temperature should be uniform. Be sure that the place is clean and not musty. Eggs for hatching should be kept not longer than ten days, and the sooner the eggs are set after being laid, the better the hatch is likely to be.

CHICK REARING

The greater percentage of chicks are range reared and with the average individual this is much the better system. There is, however, an increasing tendency to start many of them indoors for a few weeks, particularly from the early hatches. It is also a fact that each season more chicks are being raised indoors from hatching time to market age.

When chicks have no opportunity of getting out on range and eating materials that grow in the fields such as grass, insects, etc., and are kept out of direct sunlight, it becomes necessary to supply a ration which will provide for these deficiencies. It must contain not only a mixture of the cereal grains or their by-products, but a variety of animal proteins and minerals, plus the vitamins.

EXPERIMENTAL STUDIES OF THE VALUES OF VARIOUS CEREAL GRAINS IN CHICK RATIONS

Four cereal grains—corn, wheat, oats or oat groats (oats with the hull removed) and barley, together with their various milling by-products—are most commonly used in rations in Ontario. The amount of corn grown in Ontario is not sufficient to supply the needs of the poultry industry. Much of the corn used is imported and the substitution of some home-grown grains for this corn would be of economic importance. Before such a substitution can be made with any degree of safety it is necessary to know the effect of each of these grains in a ration. A series of experiments designed to study the comparative values of certain cereals in chick rations has been carried on for three years.

Fifty to sixty Barred Plymouth Rock chicks from similar matings were started on each diet immediately on removal from the incubator. These feeding trials were conducted indoors for twelve weeks in single-tiered, wire-floored battery brooders. The chicks were individually weighed each week and at the end of the experiment were examined for the amount of feathering over the back, leg development, etc.

Although various protein supplements were used, both in combination and singly, at various levels, a consideration of one series using a combination of buttermilk powder and fish meal will suffice to bring out the more important findings. It should be pointed out that the results indicate that a mixture of protein supplements will, in general, give better results than will any single protein supplement, in so far as the growth and development of young chicks are concerned. However, the efficiency of any protein supplement depends upon the other ingredients in the ration. This will be discussed later.

The diets were made up as follows:

Cereal grain	100 lbs.
Buttermilk powder	10 "
Fish meal	7 "
Alfalfa meal	5 "
Bone meal	1 "
Oyster shell	2 "
Iodized salt	½ "
Cod liver oil	1 pint.

The cereal grain was either corn, wheat, oat groats or barley alone, or a mixture of equal parts of each of these four grains. Some typical results are shown in Table No. 20 for each of the two years, 1931 and 1932. Similar results were obtained in 1933 and 1934.

In Table No. 21 are shown some typical growth responses on the individual grains with single protein supplements. These supplements were 25 pounds of buttermilk powder, or twelve pounds of fish meal, or sixteen pounds of meat meal, all supplying approximately nine pounds of crude protein.

TABLE NO. 20.—INFLUENCE OF CEREALS ON GROWTH AND DEVELOPMENT
1931

	Weights (grams) (12 weeks)			Percentage Feathering		Percentage Deformed	Percentage Beak	Percentage Mortality	Pounds of Feed per
	Average	Cockerels	Pullets	Cockerels	Pullets				
Mixed Cereals	944	957	927	24	76	2.6	2	20	3 8
Corn	953	999	901	23	70	23.5	0	17	4.5
Wheat	820	900	731	24	37	0	10	12	4.8
Oat Groats	775	835	728	23	52	0	31	17	3.4
Barley	735	734	737	32	75	0	25	40	4.8

1932

Mixed Cereals	906	955	829	22	74	5.5	11	30	4.0
Corn	957	1055	880	11	32	28.1	0	29	4.6
Wheat	968	1035	902	19	72	0	12	51	4.0
Oat Groats	844	812	890	20	70	3.4	69	40	4.6
Barley	891	936	841	36	78	2.3	45	19	3.6

TABLE NO. 21.—INFLUENCE OF CEREALS ON DEVELOPMENT WITH VARIOUS PROTEIN SUPPLEMENTS

Protein Supplement	Cereal	Weights (Grams) (12 weeks)			Percentage Feathering		Percentage Deformed	Percentage Beak Necrosis	Percentage Mortality	Pounds of Feed per Pound Gain
		Average	Cockerels	Pullets	Cockerels	Pullets	Legs			
25 lbs. Butter milk Powder	Corn	885	990	807	16	25	32	0	24	4.1
	Wheat	814	900	731	24	37	0	5	29	5.1
	Oat	845	879	787	45	78	0	20	6	3.7
	Groats									
	Barley	755	752	757	32	82	0	17	10	4.8
12 lbs. Fish Meal	Corn	760	784	732	6	21	10	2	40	5.0
	Wheat	752	753	750	34	72	6	14	46	4.8
	Oat	833	878	786	45	55	6	65	30	4.4
	Groats									
	Barley	761	783	746	43	74	3	31	46	4.7
16 lbs. Meat Meal	Corn	487	500	482	42	57	45	0	76	8.0
	Wheat	586	612	556	31	50	47	6	62	8.4
	Oat	705	776	644	32	75	3	53	33	5.1
	Groats									
	Barley	722	778	678	71	73	44	37	37	5.8

It is impossible, with our present information, to account for the differences in growth resulting from these various cereal grains, particularly when fed with a mixed protein supplement, but they do indicate the advisability of using a mixture of cereals in chick rations, rather than relying upon any single grain.

From Table No. 21 it will be seen that the various grains respond differently with various protein supplements, showing that the efficiency of the protein supplement depends, to a certain extent, upon the other ingredients in the ration. Such protein supplements as buttermilk powder, fish meal and meat meal differ in the quality of protein which they contain and the use of a mixture of such supplements in a chick ration is a safer practice. Thus the difference in the growth of the chicks fed corn with buttermilk powder, and those fed corn with meat meal, can be explained, partially at least, by differences in the quality of these two protein supplements. However, the differences in growth between the groups of chicks fed corn and buttermilk powder and those fed barley and buttermilk powder cannot be so explained.

No single protein supplement is completely satisfactory although, if the necessity arises, milk in some form is probably the safest and most satisfactory. Likewise, it will be evident from the results shown that no single cereal grain is without liability and a mixture of cereal grains is a safer practice.

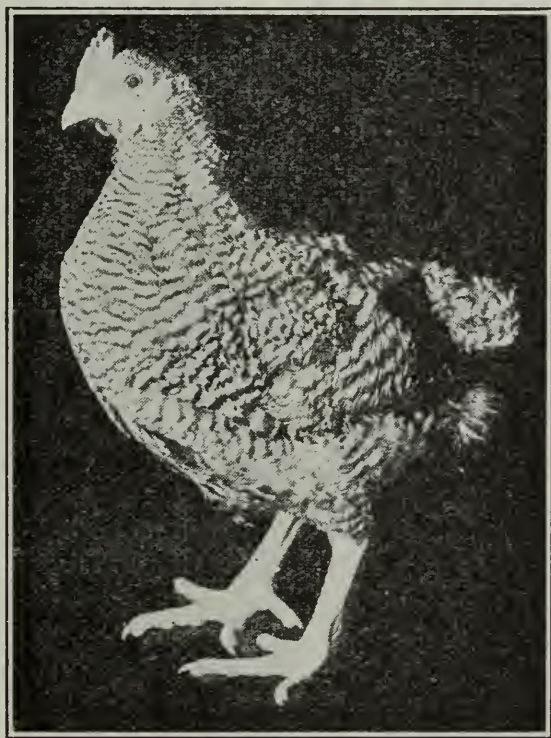


Fig. 9. A Barred Plymouth Rock cockerel showing normal bone growth, and feathering characteristic for barring and quality of feather.

The chicks raised on rations in which wheat was the sole cereal generally show a high mortality. The toxic factor responsible is not known since the various milling by-products such as bran, middlings and shorts, also resulted in high mortality if used excessively. Hence an excess amount of wheat should not be used in chick rations. Fortunately wheat is usually too expensive for such excessive usage.

The use of corn as the sole cereal results in a high percentage of deformed or crooked legs. This condition is distinct from rickets or "leg

weakness" which results from a lack of vitamin D as furnished by cod liver oil or sunshine. The condition resulting from a high corn intake is called "slipped tendons" or perosis, since the tendon at the back of the tibia-tarsal-metatarsal joint often slips from place. See Figs. 10 and 11.

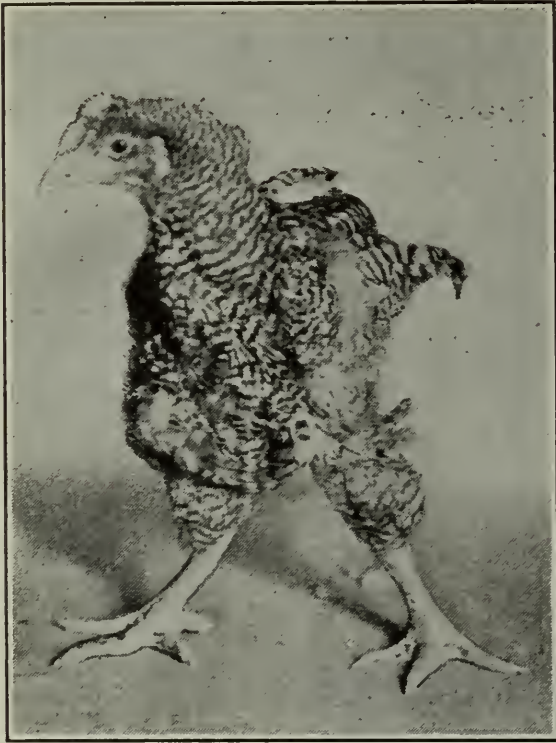


Fig. 10 Chick grown on a corn ration showing leg deformity occurring on such rations containing a high percentage of corn. Note that the tendons have not slipped from the tibia-tarsal-metatarsal joint, although the legs are bent. Also note the feather growth.



Fig. 11 An abnormal leg condition, commonly known as "slipped tendon" since the tendon slips from the tibia-tarsal-metatarsal joint (hock joint). This condition frequently occurs on a high corn intake.

In determining the percentage of deformed legs, any leg bone showing bending or bowing, or a slipped tendon, was included. The occurrence of this production of abnormal legs on a high corn intake has been repeatedly confirmed, using corn from various sources. A high intake of hominy will also cause this deformity. The development of the condition can be prevented to a considerable extent by the inclusion of oats or of oat hulls and germ, or wheat germ, in the diet. Examination of the bones of chicks fed on a corn diet shows a rather coarse, spongy bone, whereas the leg bones of chicks fed on oats or oat groats are fine, clean-cut, solid bones.

An excess of minerals in the diet will also result in similar leg deformities and will aggravate the perosis due to a high corn intake as shown in Table No. 20, where the protein supplement was meat meal, and to a less extent with fish meal. See Fig. 12.

Both meat meal and fish meal contain a considerable amount of minerals, and this mineral content added to that already in the diet will constitute an excess if large enough quantities of those protein supplements are fed. It is probably advisable to feed such mineral supplements as oyster shell and bone meal in separate hoppers and allow the birds to help themselves, rather than mixing such supplements in the mash.

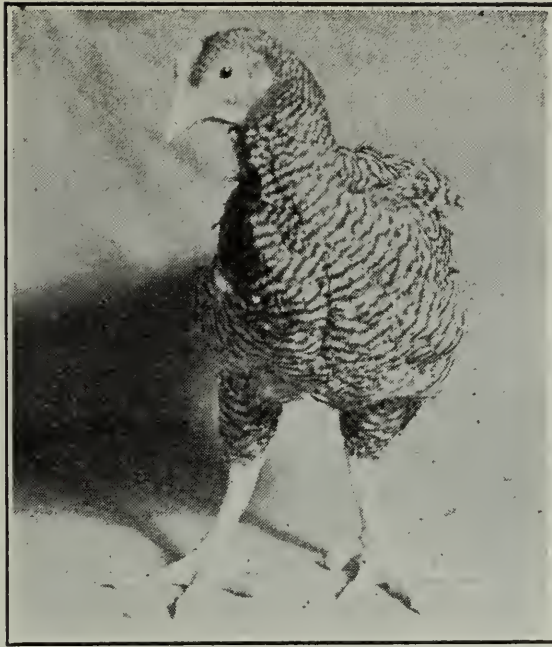


Fig. 12. Crooked legs developed as a result of an over-dosage of minerals. Note the similarity of this condition to that resultant from a high corn intake (Fig. 10).

In general, birds raised on the corn diets are slow in feathering over the back, (see Fig. 10), and it seems evident that a high corn intake is detrimental to the growth or development of feathers. The results of other experiments designed to investigate the optimum levels of protein in chick rations suggest that either a deficiency or an excess of protein also influences feathering. Either condition seems to prevent the development of the barred feather pattern in Plymouth Rocks, the barring being smutty or indistinct. Hence the amount and quality of feathering is influenced, to some extent, by the ration fed. See Figs. 13 and 14.

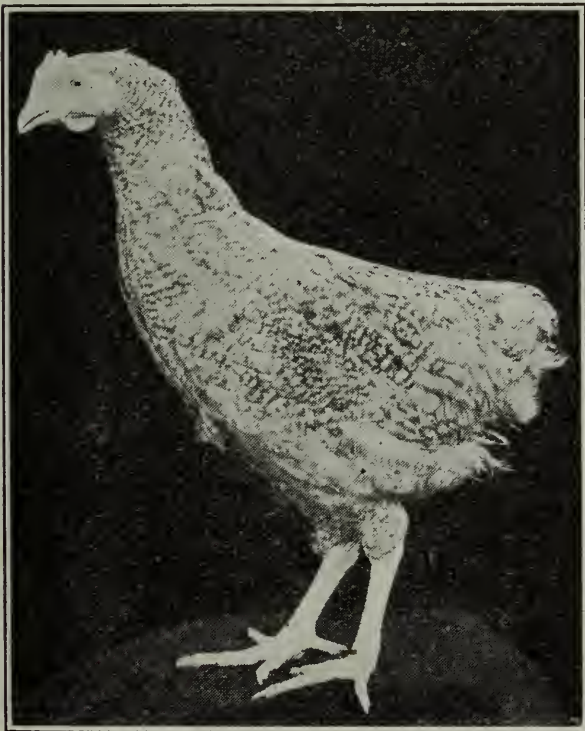


Fig. 13 Poor development of barred feather pattern resulting from improper protein level in the diet.



Fig. 14 Note the poor development of the barred feather pattern as compared with Fig. 9, the normal chick grown on a balanced diet. This condition is the result of improper protein balance.

Necrosis of the beak is believed to be due to the packing of soft, finely ground food in the beak, followed by subsequent inflammation and rotting. See Fig. 15.



Fig. 15. Chick growing necrosis of the beak, a result of using finely ground feeds that become pasty on moistening.

Finely ground grains such as oat groats, wheat and barley, which become sticky and pasty when moistened, result in this condition. Other experiments have shown that the condition does not develop if the grain is coarsely rolled or crushed, instead of finely ground.

These experiments show the advisability of using a mixture of cereal grains in chick rations. It is probable that at least two, and preferably three or more, grains should be used. No cereal when fed alone is satisfactory in every respect.

It should also be pointed out that these feeding trials were conducted in batteries indoors and that, in so far as growth is concerned, the same results might not be obtained if the chicks were raised outdoors on range. When chicks are on range they have a better opportunity to balance their ration since they eat bugs, grass and possibly obtain some nutritive material from the soil. However, it is doubtful if even range conditions would make good all the liabilities of single cereal grains. Yellow corn contains vitamin A and although other grains, such as wheat, oats and barley do contain the vitamin, the amount is small. If wheat, oats and barley are used as the cereal grain mixture in a ration, vitamin A, which is necessary for growth and resistance against infections, might be low and should be assured by another source, such as a good quality of green feed or cod liver oil.

BROODER PRACTICE

Preparing a Brooder for Chicks:

A—A colony house twelve feet square will accommodate three hundred chicks to five or six weeks of age or in other words, allow one-half square foot of floor space per chick to the age of five or six weeks, and for the

following six weeks double the amount of floor space, or reduce the flock to one hundred and fifty chicks.

B—Do not place the colony house close to trees, buildings or other obstructions to air currents, otherwise one may have considerable trouble with lack of draught and a slow burning coal fire.

C—Place your brooder as near the centre of the pen as possible, and our experience has been that the stove burns better if the pipes go straight up through the roof.

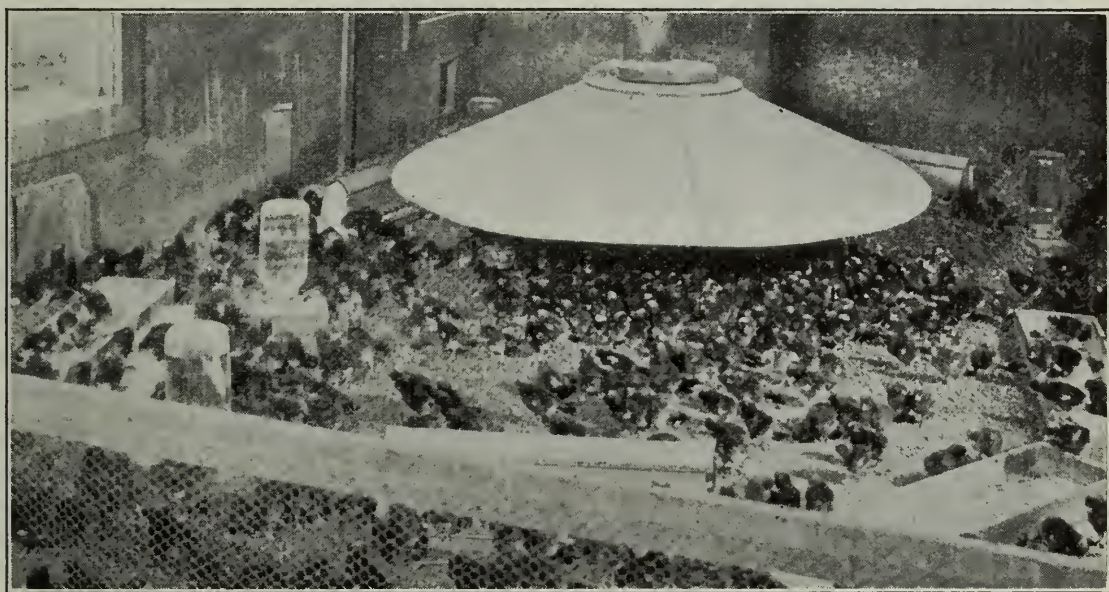


Fig. 16. Coal burning colony brooder stove, with baby chicks, hoppers and fountains.

D—The temperature of the brooder pen is important. In most cases a temperature of one hundred degrees with the thermometer placed two inches above the floor, underneath the hover, will be satisfactory. However, the best temperature guide is the behaviour of the chicks themselves. The hover temperature should be high enough that the chicks will settle down in the evening around the outer edge of the hover. They should never crowd close to the heater, due to low temperature. Battery brooding will not require as much heat as floor brooding.

E—Chilling and overheating are very apt to cause bowel trouble. The floor of the pen should be free from draughts. Early in the season it may be necessary to line the house with paper to prevent floor draughts.

F—Learn how to operate the brooder stove before you put the chicks around it, and remember that high windy days and nights mean more attention to the stove or the fire may burn out.

G—Run a circle of wire netting of one inch mesh around the hover at least two feet from its edge. This keeps the chicks near the source of heat and prevents bunching or crowding. Watch the corners of the pen. It is generally good business to put some wire netting across the corners so that the chicks cannot bunch or pile in them.

H—Use one drinking vessel for each fifty chicks. A chick hopper two feet long and open to feed from both sides is ample for fifty chicks for the first three weeks; after this age, double the number of hoppers.

I—If the sun shines in the pen near the brooder, white-wash or cover the windows for at least the first week. Chicks like to huddle in the sunshine and some broods learn to bunch or crowd in this way.

J—Keep the chicks comfortable and the air pure. The odour of the pen will suggest the amount of ventilation.

K—It is a good plan after the first week in the brooder to have a small box of grit and fine oyster shell for the chicks to eat.

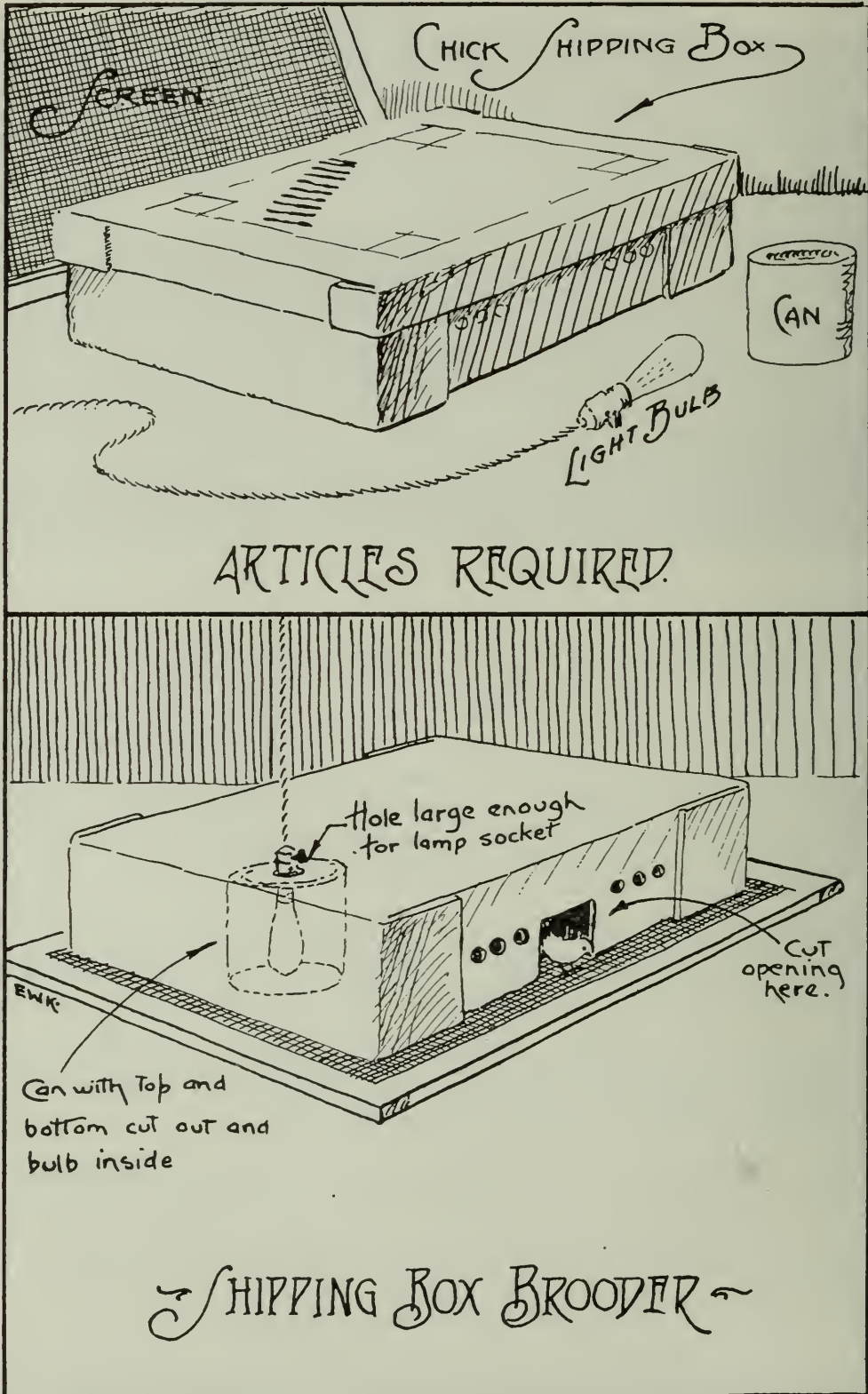


Fig. 17. Shipping box brooder, heated with an electric light bulb, 40 watts.

L—Put in small roosts as soon as the chicks desire to perch. They will sit on the perches considerably during the day, long before they roost at night; but all the time they are getting the roosting habit and once on the perch at night they require much less attention.

M—Care must be taken to keep the pen clean and dry. Do not have moist litter near the drinking vessels or anywhere in the pen. Clean the pen at least once each week, and oftener if necessary.

N—Keep the chicks comfortable.

CHICK RATIONS AND FEEDING PRACTICE

The following chick starter rations have been found quite satisfactory.

The baby chick Cafeteria ration is developed from the results of free choice feeding and has been found to give good results for either battery or open pen feeding of chicks. Chick vices are comparatively rare on this mixture.

BABY CHICK CAFETERIA RATION

16 lbs.	rolled wheat
3 "	bran
5 "	wheat germ
16 "	white hominy
17 "	ground yellow corn
5 "	rolled barley
15 "	rolled groats
5 "	rolled oats
3 "	ground peas
2 "	soya bean oil meal
7 "	skim milk powder
4 "	meat meal
1 "	fish meal
½ "	cod liver meal
1 pint	cod liver oil

For the poultryman wishing to mix his own chick ration the one given below is simpler and the ingredients more easily obtained. It also offers the opportunity to make more use of home grown materials.

CHICK STARTER RATION

Equal parts by weight of:

Ground yellow corn (grade equal to No. 2 natural)
 Ground wheat
 Ground barley
 Ground hulled oats, or ordinary oats with the hulls sifted out.

Rolling the wheat and hulled oats might improve the physical condition and prevent stickiness of the mixture.

To each hundred pounds of the mixed ground cereals, add:

5 lbs.	buttermilk powder
5 "	fish meal
5 "	meat meal
5 "	alfalfa leaf meal
½ "	iodized salt
1 pint	cod liver oil.

Where it can be secured the addition of 5 pounds of wheat germ meal to each hundred pounds of feed is advisable.

Place a hopper each of bone meal, fine oyster shell, small sized grit, and ground lime-stone in easy access of the chicks.

The cod liver oil is mixed with some ground corn and then sifted into the entire mixture. This facilitates mixing of the oil. The entire mash must then be well mixed.

Where one has plenty of liquid milk as drinking material for the chicks practically all meat meal, fish meal and buttermilk powder may be left out of the ration.

The chicks may be fed as soon as they are taken from the incubator. Chicks will live very well without food for three days. The matter of the age of the chicks at the time of the first feed is, to a large degree, a question of convenience so long as the chicks are not much over three days old.

Either of the above mixtures may be fed from the time the chicks are put in the brooder until they reach broiler age.

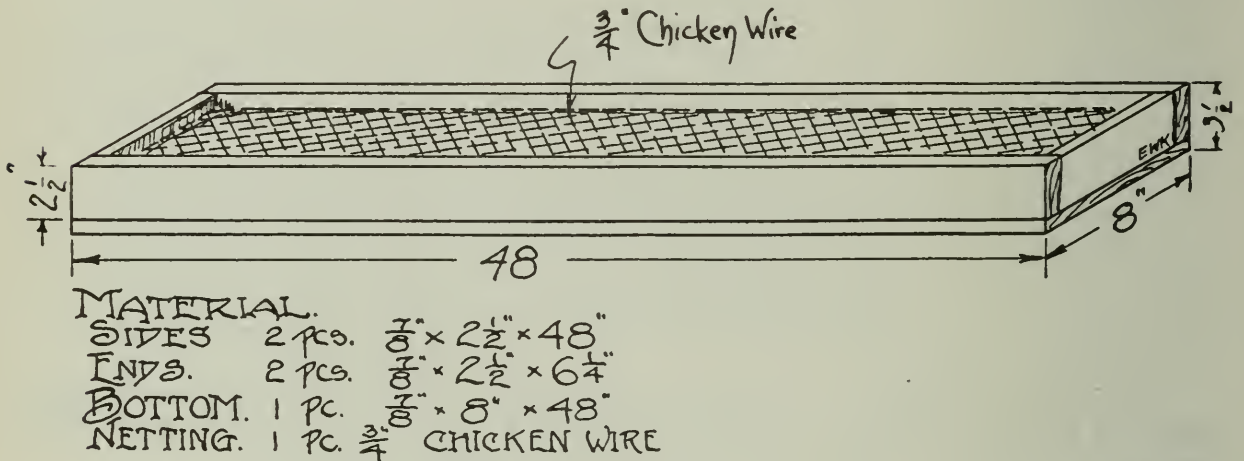


Fig. 18. Plan and specifications of a home-made chick feeder for feeding dry mash to young chicks in the brooder.

The starter mash is fed in hoppers. One may keep the feed constantly before the chicks or adopt the stop-and-go method of feeding where the feed hoppers are removed for two hours every two or three hours during the day, or two to three hours in, and two hours out.

After the chicks are two weeks old some feeders follow the practice of feeding some medium finely cracked grains such as wheat, corn and oat groats in equal parts. The practice has some points in its favour and no harm will result from the use of this material. The more hard grain eaten the less mash consumed, hence the lower is the animal protein intake. One may slow up the rate of growth unless additional protein such as milk to drink or some other form of animal protein is fed. Where chicks are in-doors it may be desirable to feed some alfalfa or clover leaves or some sprouted grains.

An abundant, continuous supply of clean, fresh drinking water must always be available.

A practice that is now followed in growing stock on range is to feed crushed oats and barley in hoppers, in addition to the growing mash, allowing the birds to make their own selection of feed. The crushed grain feeding is started a week or ten days after the feeding of the growing ration begins. Later, when the chicks are about nine or ten weeks old, equal parts of cracked corn and wheat may be fed in hoppers, in addition to the other materials. This will tend to slow sexual development and delay egg production, but will produce more growthy, larger birds at possibly lower cost.

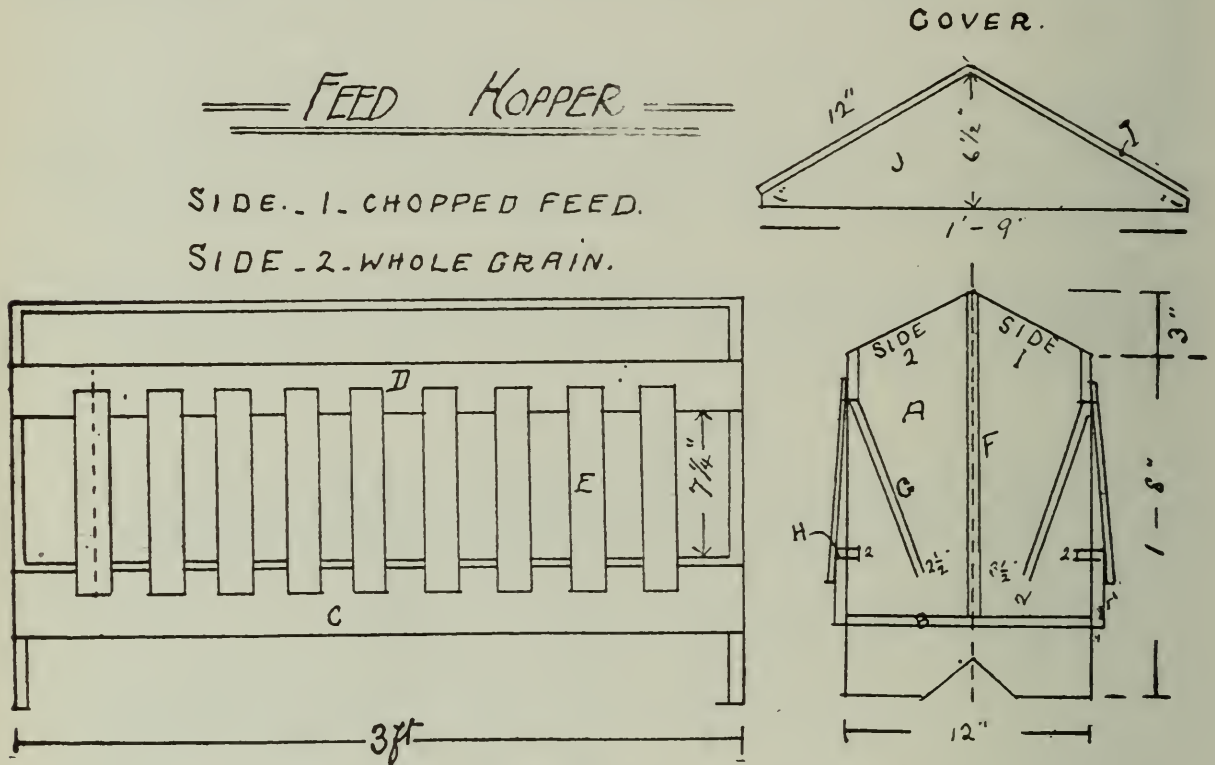


Fig. 20. Double Feed Hopper for Use on Range

- | | |
|---|--|
| A. 2 ends $\frac{7}{8}$ x 12" x 1' 8" | F. 1 division $\frac{1}{2}$ x 16" x 2' 10 $\frac{1}{4}$ " |
| B. 1 bottom $\frac{7}{8}$ x 12" x 2' 10 $\frac{1}{4}$ " | G. 2 divisions $\frac{1}{2}$ x 9 $\frac{1}{2}$ " x 2' 10 $\frac{1}{4}$ " |
| C. 2 sides $\frac{7}{8}$ x 3 $\frac{3}{4}$ " x 3' | H. 2 pieces $\frac{1}{4}$ x 1" x 3' |
| D. 2 sides $\frac{7}{8}$ x 2 $\frac{1}{2}$ " x 3' | I. 2 pieces $\frac{1}{2}$ x 12" x 3' 2" |
| E. 18 pieces $\frac{3}{8}$ x 1 $\frac{5}{8}$ x 10" | J. 2 ends $\frac{7}{8}$ x 6 $\frac{1}{2}$ " x 1' 9" |
| | (Cover) |

Side 1—Chopped feed

Side 2—whole grain

Pasturage is of great importance in growing strong, rugged, vigorous stock, and is essential with the foregoing plan. The pasturage to be efficient, however, must be in a growing, succulent state, especially during late June, July and August. Freshly sown fall rye, rape, or corn sown thickly in drills a foot apart, or any other similar crop which will continue to grow in the hot, dry weather, will be satisfactory.

Many good chickens have been grown on range on crushed oats, whole wheat and a good pasture, together with sour skim milk or buttermilk to drink. One should be careful where using crushed oats or barley to re-

move daily the hulls from the hoppers. The more fibre in the feed the greater is the need for an abundant supply of hard, insoluble grit.

Chickens can be grown in confinement but most of those so grown lack the normal bloom and condition of those grown out of doors. One may be forced to grow them off the ground owing to lack of suitable range but it is well to remember that a good grass range helps the general appearance and growth of the chickens and reduces the cost of growing them.

When chickens are on range, supply sufficient hoppers and drinking fountains. It is important that these be moved four or five feet twice a week on to fresh ground. Do not over-crowd the birds in the houses or on the range at any time. The houses should be moved frequently enough to prevent the entire killing of the vegetation near them.

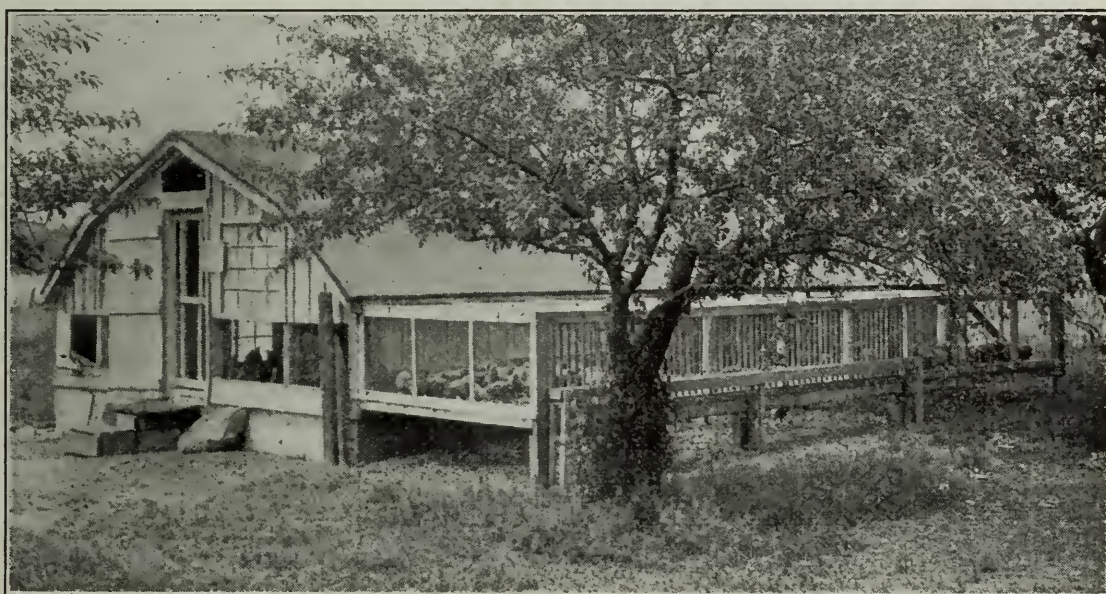


Fig. 21. Wire-floored rearing pen, of value in the control of Parasites and Coccidiosis, also for confinement rearing.

CHARACTERISTICS AND VARIATIONS IN BREEDS OF CHICKENS

The present high standard of quality of poultry has not come about by accident. It has taken many years of careful breeding to develop so many useful and beautiful breeds and varieties of chickens as are now available. Among this large variety of types and colours are to be found birds suitable for any purpose for which fowl may be desired. We have, therefore, birds in a variety of colours that are satisfactory for the production, in quantity, of either white or brown shelled eggs. Some make excellent market fowl, while still others combine a satisfactory egg production with the required fleshing to dress out a good carcass. There is also ample scope for the application of the skill of the exhibition breeder because all the above types, along with other specialized exhibition types, are beautiful as well as useful and, therefore, make splendid exhibition material.

The Single Comb White Leghorn is easily the most popular of the producers of white shelled eggs. This variety of Leghorn lays good sized eggs, stands confinement well, and can be successfully handled in large flocks. It has become popular as egg producer for both large and small poultry farms. Among farmers and others who find the production of meat, as well as eggs, profitable, the Plymouth Rock is popular; especially may this be said of the Barred and White varieties of the breed. In this class should be mentioned also the White Wyandotte, the Rhode Island Red, and perhaps the Canadian breed of Chantecler. The Orpington and Sussex breeds also supply varieties suitable for this purpose.

Where the production of table fowl is stressed the Cornish Game, and more especially the first cross of the Cornish with Orpings, Jersey Black Giants, Plymouth Rocks or Brahmas, are satisfactory. Some strains of Plymouth Rocks, Wyandottes and Rhode Island Reds produce birds that dress out well. Other varieties of the above breeds are also useful commercially but are more popular for exhibition purposes.

Not all birds nor all strains of any one variety are equally good for egg production, meat production, or as dual purpose fowl; nor is one breed or variety necessarily superior to any other. It is possible, within certain limits, to select out of almost any variety birds excellent in meat or egg production, or birds of an intermediate type. Breeding from only such selected birds will soon result in a strain adapted to the purpose for which the selection is made. Where one has a preference for any particular type or colour of bird almost any suitable breed and variety may be chosen and then developed by selection for any purpose required of it. Trapnesting, pedigreeing and progeny testing of the stock will facilitate the attainment of the desired goal.

In the production of these numerous breeds and varieties of fowl much credit is due the American Poultry Association, organized by representative poultry breeders of the United States and Canada in 1873. The "American Standard of Perfection," issued by this Society, has aided greatly in bringing about uniformity in breeding results. It has served as an incentive to greater effort on the part of many breeders. In it is described and illustrated the ideal in colour, shape and other points of each recognized breed and variety of chickens, as well as of geese, ducks and turkeys. The Standard is revised at intervals to keep up with the changing ideals of the leading breeders of the various breeds and varieties. In this way stress is placed on the breed characters which changing conditions in the trade, as well as in the show room, indicate should be emphasized.

Practically all present day breeds and varieties of chickens are the outcome of crosses made between birds of various types, colours and comb conditions. These crosses were followed up with rigid selection towards an ideal until such ideal was, to a degree, attained. While careful selection has brought about considerable purity among the breeds and varieties, there are still numerous indications of impurity. These are known as standard disqualifications and since the majority, if not all of them are hereditary every breeder is well advised to discard all birds carrying such disqualifications. It is just as important for the

production breeder to cull severely in this regard as it is for the exhibition breeder to do so. The purity and quality, as well as the egg production, are dependent on the attention given these points by breeders of production birds. This is true of poultrymen supplying hatcheries with eggs as well as those operating breeder hatcheries.

POULTRY BREEDING

In the breeding of poultry there are two main points to be considered; first, the selection of birds that have the characters desired; and secondly, a further selection from these of birds that can produce offspring as good as or better than themselves.

Many are of the opinion that "like begets like." In general this is true, but it is true for general and not necessarily for particular qualities. It is true that a White Leghorn male mated to White Leghorn females will breed chickens that are White Leghorns, or that have white plumage, yellow legs and white ear lobes, but of these offspring there will be no two chicks exactly alike. We find large and small Leghorns; most of them never go broody but some do; some lay large eggs, others small eggs. We also find a great variation in the number of eggs produced by different hens.

Selection is made on the basis that like will produce like, but experience has taught many breeders that to secure uniform superiority they must carry on the selection through generations of poultry. If we select birds that have laid better than two hundred eggs in twelve consecutive months and mate these to a male of similar strain, we do not expect to get daughters that will all lay two hundred or more eggs a year, but we do expect, on the average, a better production than if no selection had been made.

SELECTION

The first step in the breeding of poultry is the selection of the birds to make up the breeding pen. What birds are used in this pen depends upon the object of the breeder. Selection is made along the lines of the ideal in mind. The higher the ideal the fewer will be the individuals that will be considered suitable for the breeding pen.

No matter what may be the breeder's ideal, all agree that vigour is the one essential point that must always be present; that is a bird must be healthy and active. Vigour means the bird's ability to thrive and live under ordinary conditions. The lower the vigour, the more easily the birds will sicken and die. Perhaps the male, which is the boss of the entire flock, is the most vigorous or at least it would be safe to say he has considerable vigour.

It is important that the breeder should bear in mind that the vari-

ous characters of the chicken may be inherited separately. Because Plymouth Rocks, for example, have single combs, red ear lobes and yellow legs does not mean that all such birds having yellow legs must have single combs and red ear lobes. By means of this inheritance of single characters, the breeder is enabled to correct single defects in the birds bred, and at the same time maintain and improve the good points.

It is, therefore, plain that the first essential is the selection of birds that have the characters wanted, and the next step is to test their power to transmit these characters. Our experience has been that certain birds, male or female, are excellent for breeding one character but fail in others; for instance, hen H 19 has never bred a bird without positive bright yellow legs. She appears to be able to transmit this character to all her offspring. Again, we find birds that transmit several desirable characters very well, but may likewise transmit one very undesirable character. As an example of this, male 2227 produced daughters that were very satisfactory in all respects with the exception of size and colour of eggs. In the end the breeder selects, then tests the selected birds for their ability to produce offspring as good or better than themselves.

The most interesting and at the same time the most progressive method of breeding is to know the parentage of each chick, and thus be able to tell which birds are reliable breeders. There is a great difference among birds in their ability to transmit certain characters, as one may find in any ordinary selecting process in a pure-bred flock. Some birds are good breeders; others appear to be of very little account.

The more selections that are made and the more tests of progeny, the less is the percentage of undesirables found. One may expect some considerable variations within a group, but one may likewise expect a smaller number of inferior stock with each generation.

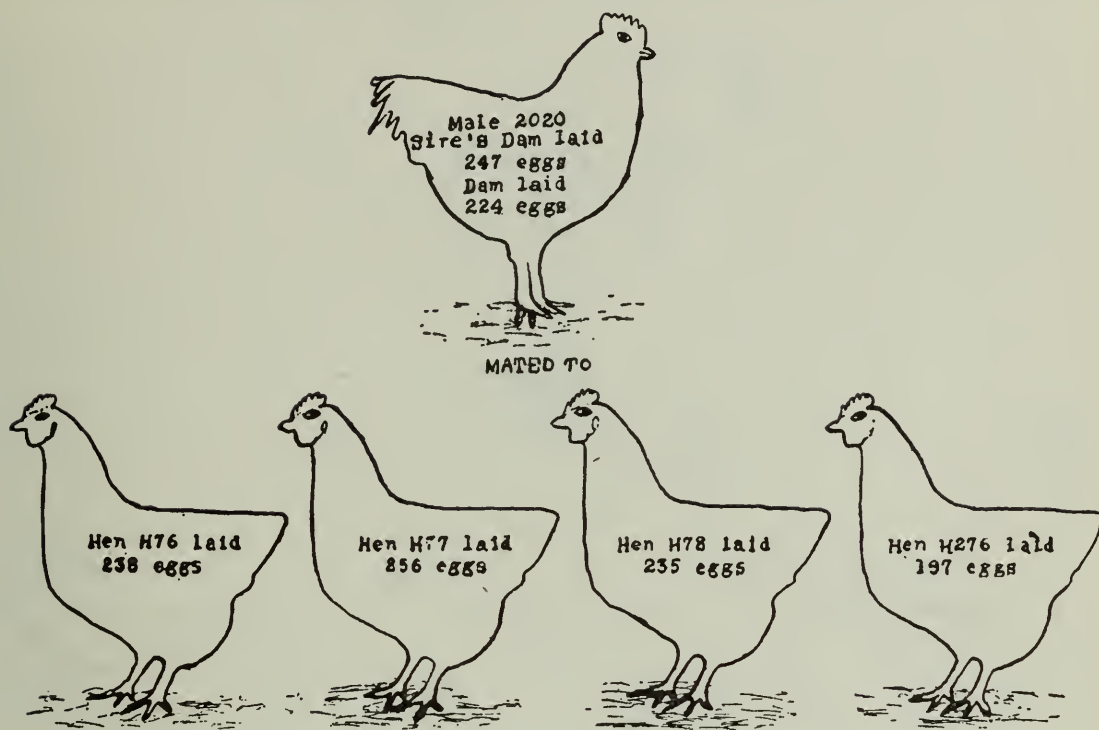
PROGENY TESTING

The following tables give the results of a test of four Barred Rock males and the hens bred to them, each of which has had four or more daughters that completed a year's trap-nest record. Where a hen has fewer than four pullets it is more difficult to estimate her value as a breeder. The results from hens with less than four daughters do not alter the indicated value of the male as a breeder beyond the figures given. They are of some interest in establishing the value but where space is limited it has been considered wise to omit such hens from the figures given.

It must be remembered that in this progeny test only the number of eggs laid are considered. This is some indication as to the hens' ability to produce pullets, as is indicated by H 237, H 19 and H 262.

A practical breeder would have to bear in mind such things as breed-type and colour, size and colour of eggs, hatchability, growth of the chicks and the number of eggs set to secure a mature bird.

Results of breeding Male 2020 to Hens H 76, H 77, H 78 and H 276



Daughters		Daughters		Daughters		Daughters	
Eggs laid		Eggs laid		Eggs laid		Eggs laid	
L 379	171	L 45	189	L 106	157	L 319	177
L 440	253	L 311	162	L 194	245	L 416	166
L 2631	133	L 386	221	L 479	165	L 487	184
L 3433	162	L 2637	171	L 2518	123	L 2551	155
L 3220	151			L 2607	115	L 2641	172
						L 2649	141
						L 3429	139

Notes on Male 2020

Male 2020 is the son of a 224 egg hen. The dam of his sire laid 247 eggs.

He was successfully bred to four hens which produced four or more daughters with trap-nest records for a year.

The mating produced three hens that laid two hundred or more eggs in their first year.

H 76 produced the highest laying daughter and this daughter's record exceeded her mother's.

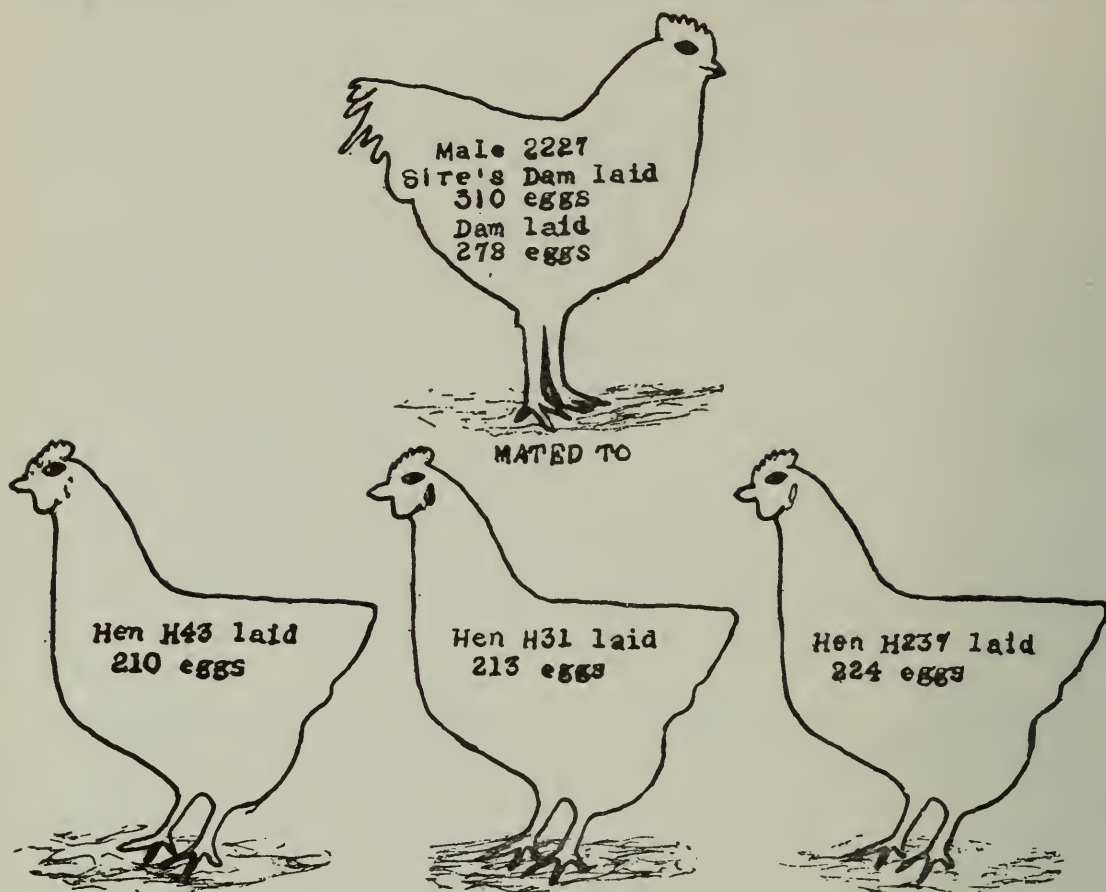
H 77 produced one daughter that laid two hundred eggs but was not as good a layer as was her mother.

H 78 produced one daughter with a record higher than the mother's.

H 276 produced no daughters equal to herself.

This mating would be considered very ordinary from the results obtained. From such a mating one would not expect future generations to be any better than the parents.

Results of Breeding Male 2227 to Hens H 31, H 43 and H 237.



Daughters

Eggs laid

L 208	260
L 375	228
L 491	194
L 2526	130
L 2557	179
L 2572	191
L 2628	123
L 3436	193

Daughters

Eggs laid

L 303	219
L 377	271
L 2529	242
L 2572	254

Daughters

Eggs laid

L 70	202
L 221	204
L 318	227
L 352	244
L 400	227
L 437	224
L 474	249
L 492	223
L 2516	213
L 2582	190
L 2630	243
L 3905	235

Notes on Male 2227

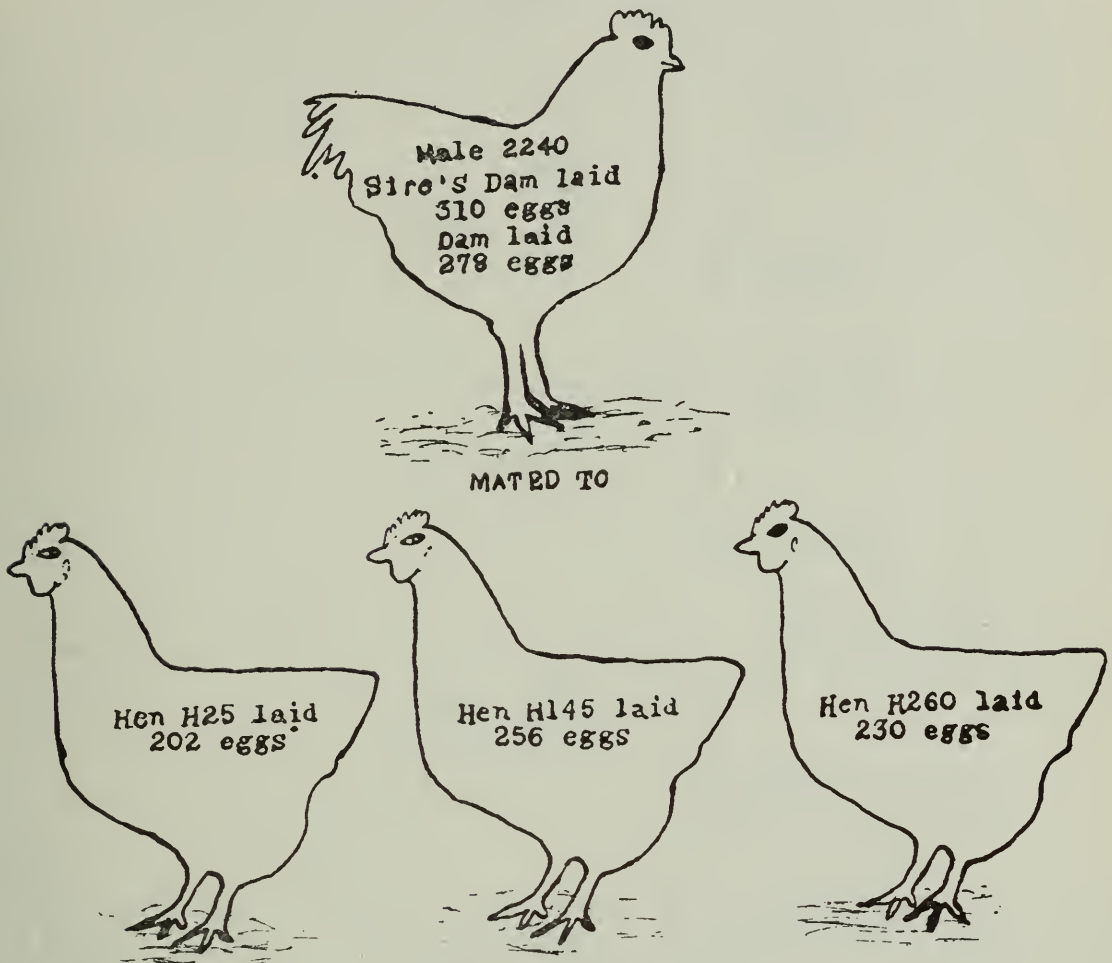
The general results of this mating were exceptionally good. Our experience has been that but few matings produce as many high laying birds as did this one.

Hen H 31 produced daughters all of which were better than herself. She also produced the highest laying individual.

Hen H 237 had a large number of daughters, indicating exceptional breeding ability for numbers. It is rare to get a hen with so many daughters that are all good layers. This is a very excellent hen and should be good foundation for a high laying family.

Hen H 43 did not breed as many high laying daughters and there is a wide variation among them. It is questionable if this hen had been bred to an average male whether her offspring would be very good. Sons of Hens H 237 and H 31 should be good males from which to breed.

Results of Breeding Male 2240 to Hens H 25, H 145 and H 260.
(Male 2240 is a full brother of Male 2227)



Daughters

Eggs laid

L	15	.....	169
L	404	.....	211
L	451	.....	183
L	483	.....	214

Daughters

Eggs laid

L	407	.....	224
L	439	.....	145
L	2612	.....	147
L	3208	.....	187
L	3210	.....	134
L	3215	.....	147
L	3237	.....	183

Daughters

Eggs laid

L	369	.....	263
L	392	.....	202
L	2573	.....	222
L	2599	.....	105
L	2648	.....	180

Notes on Male 2240

The daughters of Male 2240 were, on the average, distinctly lower in egg production than those of his brother, 2227.

Hens H 260 and H 25 indicated that they would breed good stock. One would particularly desire to see the offspring from these hens mated to such a male as 2227.

Hen H 145 had no daughters equal to herself and most of the daughters were low producers. This hen would be discarded as a breeder.

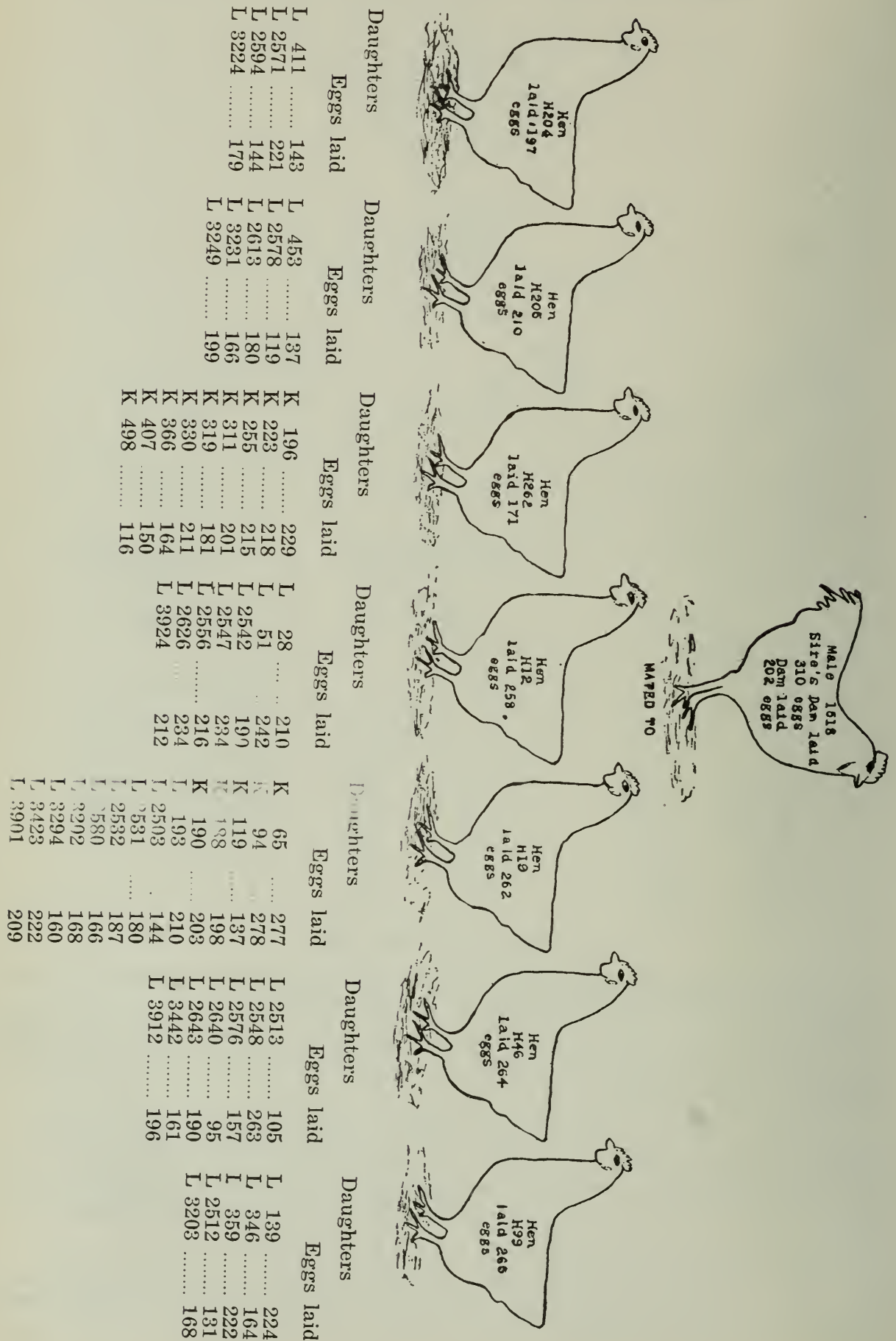
Hen H 260 had one very poor daughter. Without further trials it is questionable what bearing this would have on her future breeding.

Hen H 25 had two daughters better than herself.

The good pullets from H 260 and H 25 would be worth using in breeding trials. The cockerels might be good breeders but one would prefer them from a better male.

Results of Breeding Male 1518 to Hens H 12, H 19, H 46, H 99, H 204,
H 205 and H 262.

(Male 1518 is a half brother of 2237 and 2240)



Notes on Male 1518

Male 1518 was successfully bred to more hens that produced four or more daughters than any other males. He is a rather interesting male in that he has produced many variations, not only in the range of egg production from his daughters but in the way of the daughters from the different hens performed.

The most successful mating was H 12. The daughters of this hen were uniformly good.

H 46 produced a wide range of daughters and the average results were not very good.

H 19 produced some high laying daughters and the average of all was very good.

H 99 performed much after the manner of H 46 but the average was better.

H 204 was in the same class as H 46 and H 99.

Hens H 205 and H 262 are full sisters and therefore the results from these two hens become very interesting. It will be noted that it is not always the highest laying hen that is best bred, nor yet the lowest. (Compare H 12 and H 262.)

The hens H 205 and H 262 are an excellent example of the value of testing the progeny for the characters under consideration.

H 46, H 99 and H 204 appear to be rather inferior breeders.

TABLE 22.—GENERAL RESULTS FROM ALL THE PENS

Mother	Egg Production of Mother	Number of Daughters	Average Egg Production of Daughters	Eggs Total
H 12	258	7	219.7	1538
H 25	202	4	194.25	777
H 31	213	4	246.5	986
H 43	210	8	187.25	1498
H 46	264	7	162.4	1140
H 76	238	5	174.	870
H 77	256	4	185.75	743
H 78	235	5	161.	805
H 99	265	5	181.	905
H 19	262	14	195.	2730
H 237	224	12	223.4	2681
H 145	256	7	166.7	1167
H 204	197	4	171.75	687
H 260	230	5	196.6	983
H 276	197	7	162.	1134
H 205	210	5	159.6	798
H 262	171	9	187.2	1685
Total Production	3888	112	3174.1	21,127
Average Production	228.7		186.71	188.63

It is not to be expected in the general results from a selected number of high laying hens that all the daughters will be high layers, or that the mother only controls the producing ability of the daughters.

Study the following tables as to the variations in breeding ability:

TABLE 23.—THE INFLUENCE OF THE MALE

	Mother's Egg Production	Number of Daughters	Average Egg Production of Daughters	Total Eggs
Male 1518 bred to H 12	258	7	219.7	1538
H 46	264	7	162.4	1140
H 99	265	5	181.	905
H 19	262	14	195.	2730
H 204	197	4	171.7	687
H 205	210	5	159.6	798
H 262	171	9	187.2	1685
Total	1627	51	1276.6	9483
Average	232.4		182.3	185.9
Male 2020 bred to H 76	238	5	174.	870
H 77	256	4	185.75	743
H 78	235	5	161.	805
H 276	197	7	162.	1134
Total	926	21	682.75	3552
Average	231.5		170.6	169.1
Male 2227 bred to H 31	213	4	246.5	986
H 43	210	8	187.25	1498
H 237	224	12	223.4	2681
Total	647	24	657.15	5165
Average	215.6		219.	215.2
Male 2240 bred to H 25	202	4	194.25	777
H 145	256	7	166.7	1167
H 260	230	5	196.6	983
Total	688	16	557.5	2927
Average	229.3		185.8	182.9

Summary

Of the four males under test, Male 2227 was the best breeder of high laying hens, and Male 2020 was the poorest.

Male 1518 bred some good daughters and by careful selection a very good line could be established, especially from the cockerels of H 12.

If one desired high laying hens and considered this character only, by taking Male 2227 and Hens H 12, H 31, H 237, H 19, H 262, H 25, H 260 and H 77, he would be reasonably sure of getting a number of pullets that should average at least two hundred or more eggs.

Male 2240, being a full brother of 2227, and having proven himself an inferior breeder, would be discarded.

As a matter of fact Male 2227 has a fault, in that his daughters do not lay eggs of good size and colour, and the breeder might consider seriously mating 1518 who does produce pullets laying eggs of good size and colour, in preference to Male 2227; or a cockerel from Hen H 12 bred to the daughters of 2227 would be a mating worth serious consideration.

The remaining hens, if one were short of breeders, could be tested another season by mating these to different males, but one is not likely to get daughters of a very high average from them. It is likely that one will test hens like H 46, that have laid two hundred and sixty eggs, with several males in an effort to find a male with which she will produce daughters her equal or better. Occasionally one is successful.

Our experience has been that by breeding from what appear to be the best sons of the good breeding hens a little progress is made from year to year, whereas the use of a male, simply because his mother was a high layer, may result in a decrease in production.

Pedigree breeding and progeny testing take considerable time and necessitate accurate records. Where one desires to buy males or females from such stock the purchaser should expect to pay a higher price. The labour involved in pedigree breeding, if well done, will double the cost of the ordinary chicken.

Considering that many are interested in what happens when an ordinary hen is bred to a male such as 2240 from a fairly good hen, the following results from such a mating are given:

Hen 114 laid one hundred and twenty eggs in her pullet year and five of her daughters were trap-nested with the following results:

K 261	laid	156	eggs
K 263	"	221	"
K 365	"	135	"
K 453	"	135	"
K 489	"	147	"
The average of the group was 158.8 eggs.			

Experience has demonstrated many times that with reasonable care and feeding, egg production of one hundred and fifty eggs or even better can be secured by using sons of two hundred egg hens. However, to secure a flock average of one hundred and eighty to two hundred or more eggs, from a flock of three hundred to one thousand birds, requires careful breeding.

Where one wishes to establish lines for longevity it is necessary to breed two or three year old males to hens of similar age or older. In such case it would be necessary to do the breeding in late March or April as old males will not breed satisfactorily in the cold weather.



Fig. 22. H69 laid 249 eggs in her pullet year.



Fig. 23. K182 laid 220 eggs in her pullet year, 198 in her second year.



Fig. 24. L48-L49 is a son of H69.



Fig. 25. M1039-M1040 is a son of K182.



Fig. 26. H19 laid 262 eggs in her pullet year.



Fig. 27. K186 laid 271 eggs in her pullet year.



Fig. 28. K1801 laid 253 eggs in her pullet year, 196 in her second year.

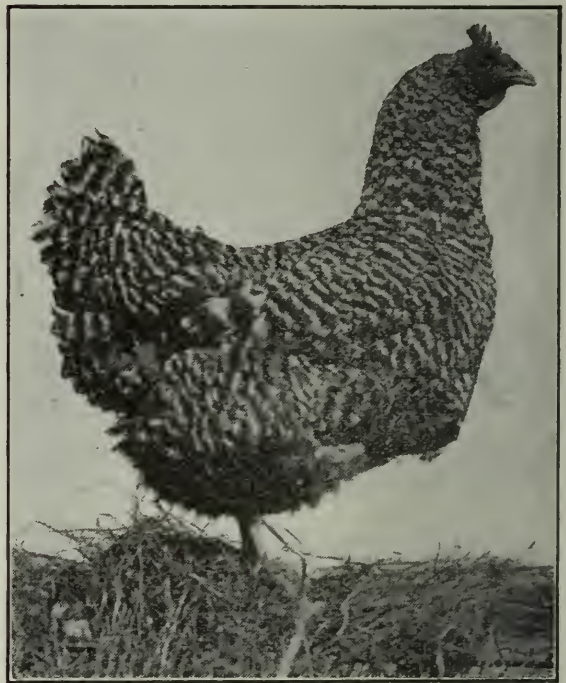


Fig. 29. G29 laid 202 eggs in her pullet year, 194 in her second year, 180 in her third year, 143 in her fourth year.

BREEDING MARKET POULTRY

There has been a tendency during recent years in selecting and breeding for high egg production to overlook the importance of market poultry. The records of the Poultry Breeding Station flocks over the past six years would suggest that the majority of flock owners are securing a larger annual revenue from market poultry than they are from eggs.

Depth of body, from the top of the back to the bottom of the keel, has been emphasized as indicating capacity in a laying hen or breeding male. In many cases birds were selected with deep keels, but narrow bodies, and very poor breast fleshing.

Body capacity is extremely important but one should avoid narrow bodied, deep, bare keeled birds. The front end of the keel must be free of a sharp bare point, as it is impossible to cover this in fattening. Such birds are also more susceptible to bruising of the keel, resulting in abscess formation and thereby seriously reacting on the bird's market value. It is important to see that the lower edge of the keel blends in as smoothly as possible with the fleshing of the breast. Such a bird when fatted and dressed will present a smooth, round, plump carcass. Selection of this type of breeding bird need not react on the bird's egg producing qualities as it is still possible to secure in such birds good body capacity, due to length and spring of rib.

Rate of feathering in the chicks is important as the rapid feathering strain will show less pin feathers on dressing than a slow feathering strain and hence is easier dressed. Feeding will, of course, affect this condition but breeding selection is nevertheless important.

POULTRY CULLING

Weeding Out the Unprofitable Layer

A hen's appearance and handling qualities change in relation to whether she is in laying condition or not.

When a hen is laying, or approaching laying condition, the colour of the comb brightens, the skin becomes soft and loose, and the bird generally appears more thrifty and active. Many good laying hens when out of production, due to season moulting or unfortunate management, etc., may have the general appearance of a poor laying hen.

It is therefore well to keep in mind that the sorting of hens into groups of poor and good layers is best done when the birds are laying reasonably well. The characters used indicate quite easily whether the hen is laying or not and give considerable information as to the probable number of eggs the hen has laid in the past few months.

How to Hold and Handle Birds in Culling

The amateur poultryman often experiences considerable inconvenience in handling birds, and often causes the bird much worry. Fig. 30 shows the proper way to hold a bird. The hen, when held in this way, with the breast resting on the arm, and with one's first finger between the hocks, and the thumb and second finger used to grasp the upper shank, will rest quietly and give one a chance to examine the various points to be considered.



Fig 30. Method of holding bird.

Head Types. The head tells an interesting story. It is an index as to what may be expected in the body type and in the performance of the hen. The head should be clean cut, of medium size, not too long or crow-headed, and not too short and bunty. The crow-headed type is an indication of low producing ability, and often a lack of vigour. The short, beefy head indicates a sluggish type and is often correlated with a predisposed tendency to fatten, and with low egg production.



Fig. 31. Side view of good head.



Fig. 32. Front view of good head.

The illustrations show several interesting features in heads. Figs. Nos. 31 and 32 show heads with abundance of character. Note the well-turned beak, the fine texture of skin about the face, and the bright, prominent eyes set well back in large, oval eye sockets. The eyes are set close to the top of the skull with their long axes parallel with the line of the top of the skull and the beak. Note the absence of beefiness or wrinkles over the eyes and about the face. The top of the head is inclined to be flat and fairly wide. This width is carried well forward towards the nostrils. The line made by the top of the beak and skull is straight, thus avoiding an undesirable tendency to dish at the nostrils. The comb is waxy and bright. Both heads show marked indication of vigour, strength, activity and quality.

Compare these heads with those shown in Figs. 33 and 34. Here, on the one hand, is shown the rather round, narrow skull and long pointed beak of the too refined bird. On the other hand is the head with wrinkles of fat over the eyes and a coarse skin about the face. The full, sluggish eyes are set in close, rather round sockets, not so close to the top of the



Fig. 33. Side view of poor head.
(Crow head.)



Fig. 34. Side view of poor head.
(Fat head.)

head nor are the long axes of the sockets as parallel with the top of the head. These heads do not show the strength, character nor quality exhibited by the heads of the previous two birds. One should avoid extremes.

Body Conformation. The type can easily be ascertained by handling. Holding the bird as described above, take the other hand and place the thumb over the middle of the back and let the fingers fall along the side of the bird to determine the length and spring of rib. Here are located all the vital organs such as the heart, lungs and digestive organs which must function efficiently, to assist in producing eggs and in repairing worn out body tissue so that the bird can stand the wear and tear of heavy production.

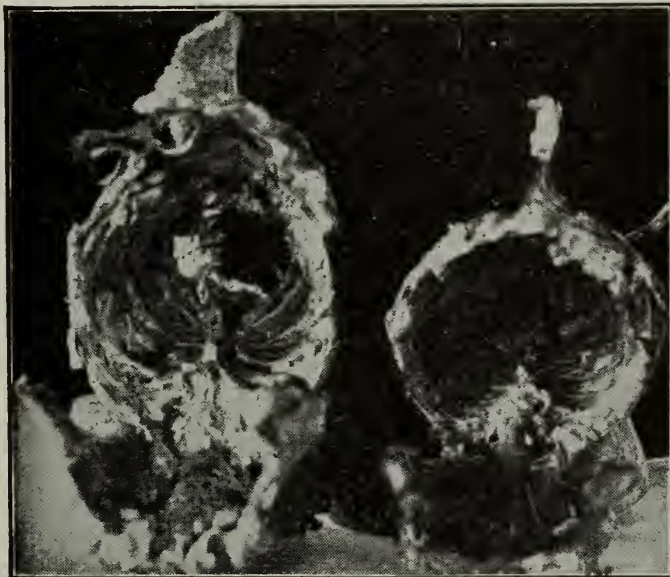


Fig. 35. Rear view of skeletons.

If the hen is to develop speed as a layer these organs must have room in which to operate. Thus we find that the hen must possess good spring of rib and a deep, flat side. Fig. 35 shows the difference in the length and spring of rib in high producing hens as compared with low producers.

Note the deep, flat side of the high producer, and the round, shallow body of the lower producer. This can be determined by handling as described above.

The back should be of good length and with good width carried well out from the hips to the pubic bones. Note Figs. 36 and 37.



Fig. 36. Broad, flat back, carrying its width to the tail.



Fig. 37. Rounded back, forming a wedge with the tail.
(Poor type.)

The shape of the keel bone is important. It should run back either parallel with the back or slope downwards. It must be long to support the abdomen, or egg sack. In high producers the keel frequently has a decided hook, or downward turn, at the rear end. This is a good feature and, while not always found, is generally a sign of early and persistent production in the early part of the pullet year. The undesirable type of keel is one which tends to turn decidedly upward toward the vent and birds having such keels are often described as being canoe keeled.

In order to determine the capacity of the egg sack the hand can be placed at the rear of the bird, as shown in Fig. 38. The lower finger can readily find the position of the end of the keel, and the first finger the position of the pubic bones. These pubics are two thin bones projecting out one on each side of the vent and just above it. The measure of the distance from these bones to the end of the keel is called the capacity and is spoken of in terms of the number of fingers one is able to insert.

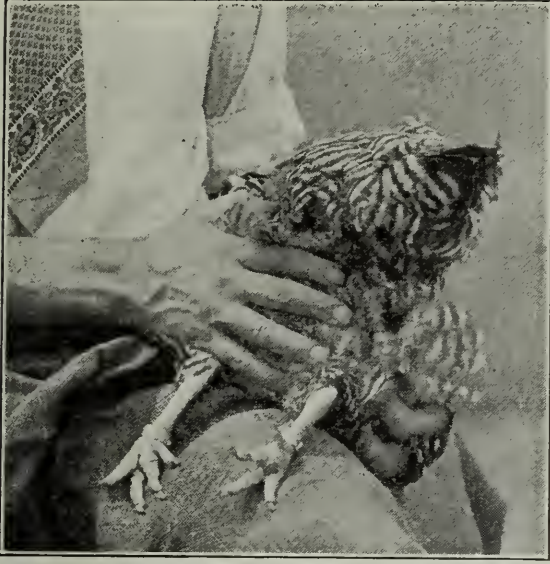


Fig. 38. Good capacity—239 eggs.



Fig. 39. Poor capacity—67 eggs.

Fig. 39 shows a poor producer with a canoe keel and only a two finger capacity. Compare this with the hen shown in Fig. 38, having more than a four finger capacity, and note the relation of this capacity to the production of the birds.

The capacity of a hen is not always the same. If the ovary is dormant and no eggs are being manufactured the capacity will be rather small. However, as soon as ovulation commences the distance between the pubic bones and the keel begins to increase and in full ovulation, or at a hen's highest production, the capacity of the bird will be the greatest.

Anyone who has dressed hens will have noticed a large accumulation of fat in the abdomen of some birds. This accumulation can be determined while the hen is living by handling the flesh in the egg sack. The fat, if present, will be hard and firm. This is a sign that ovulation has ceased and that the hen is now using her feed supply to lay up body fat instead of for the production of eggs. If a hen has accumulated a quantity of hard fat in the abdomen it is an almost certain indication that her laying days are about over. It is about time that her stay in the flock is terminated and that she should be sent to market.

Handling Qualities. This term refers chiefly to the quality of the skin in the egg sack. As noted above, there should be no hard fat. The skin should be soft, pliable, loose and elastic to the touch. It should not have a tough, hard nor leathery feel. This quality of the skin is closely related to the quality of the skin about the face of the bird. The coarse textures can be readily noticed in the face and is found to carry throughout. It is a sure sign of a lack of quality.

Shanks and Toes. Quality in some shanks is indicated in much the same way as in good horses. The legs should be flat but the bone not too fine. Often in poor type birds the legs are more angular or inclined to be round and hard. The scales of the shanks should be medium in size, fine in texture and should over-lap each other smoothly, giving the surface a kid glove finish. The toe-nails carry the index to the amount of scratching the hen is doing. A good layer is always a good worker and her toe-

nails will be well worn down from scratching. This will vary with the kind of pen the hen is in. A concrete floor will wear the toe-nails much faster than will a wood or earth floor. This feature, therefore, must be compared with other birds housed under similar conditions. The colour changes in the shanks are important and will be described later.

Condition. A hen will not lay if in poor condition. She should be healthy, free from all disease and should show plenty of vigor and activity. The first pullet to lay in the Fall is the early maturing one. The pullet that is a slow grower is slow in feathering out and is also a slow layer. The condition of moult is important. Shortly after a hen commences to moult she uses a part of her feed to manufacture feathers and her egg production is lowered, or in many cases ceases entirely. Some hens moult much earlier than others. If a hen commences to moult in July her laying for the Summer is about over. It may safely be said that late moulting and heavy egg production are correlated because it gives the hen a longer period of continuous production. Such hens usually moult quickly and are again back in full feather in time for winter production. It is a peculiar fact that those birds commencing their moult early in the Summer usually moult slowly and are often late in returning to laying condition in the Fall. The late but rapid moulters frequently commence laying just as soon or sooner.

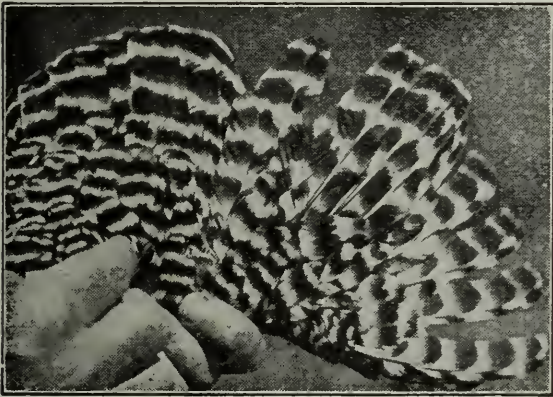
Plumage. If a hen is laying heavily the plumage will become dry, hard and brittle. The lustre will disappear and the feathers become broken. The hen certainly loses much of her natural beauty but she cannot retain that bright lustre and also keep up heavy production. Watch for the hen with a full array of feathers, all in good form, and see if she is not one of the boarders in the flock.

When is a Hen Laying? When the ovary is dormant and no eggs are being produced the distance between the pubic bones is very small. The vent is dry, small, puckered and in yellow fleshed birds a band of yellow pigment appears around the inner border. When laying commences the pubic bones become pliable and spread apart. The distance may increase from one to three fingers' width in a short time. The vent becomes large and moist and after two or three eggs have been laid the ring of yellow pigment has disappeared and the vent is bleached.

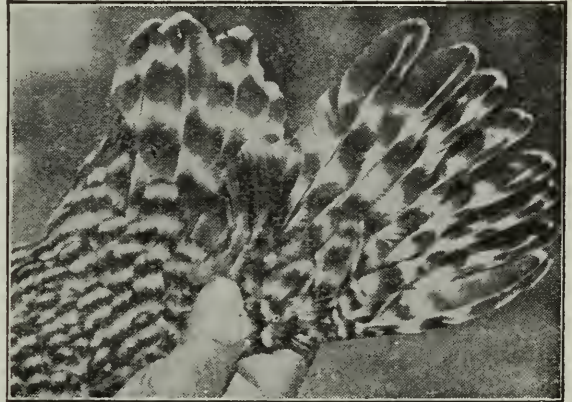
Further Colour Changes. The first change in pigmentation is in the yellow ring just around the vent. Two or three eggs will remove this colour. The colour then leaves the eye ring, the skin just around the edge of the eye-lid. It usually requires about six eggs, or from ten days to two weeks of production, to remove the yellow colour from this part. At about the same time the colour starts to leave the beak, commencing at the rear of the bill, and gradually fades. There is quite a distinct line of demarcation between the yellow area and the white. As laying proceeds the white area increases, gradually fading the yellow out towards the tip of the beak. When the colour is entirely gone from the beak the hen will have laid about thirty eggs, which requires about six weeks' time. The shanks are the next part to show colour change. After the colour has left the beak it commences to leave the front of the shanks, the white area here also appearing and the yellow receding down the front of the shanks and from the foot up the back of the shanks, the last trace of yellow being on the back of the hock. It requires about one hundred and fifty eggs, or from five to six months of persistent production, to entirely remedy the

colour from the shanks. There is a difference in the rate at which this colour will disappear. Feeding plenty of green feeds tends to produce yellow colour and to prevent its disappearance. Birds closely confined during the Winter show the colour changes more plainly, and with less production, than do birds in Summer on range where they are receiving an abundance of green feed. Small sized birds for the breed, and those lacking somewhat in vitality, lose the yellow pigment more rapidly than do larger and more vigorous birds.

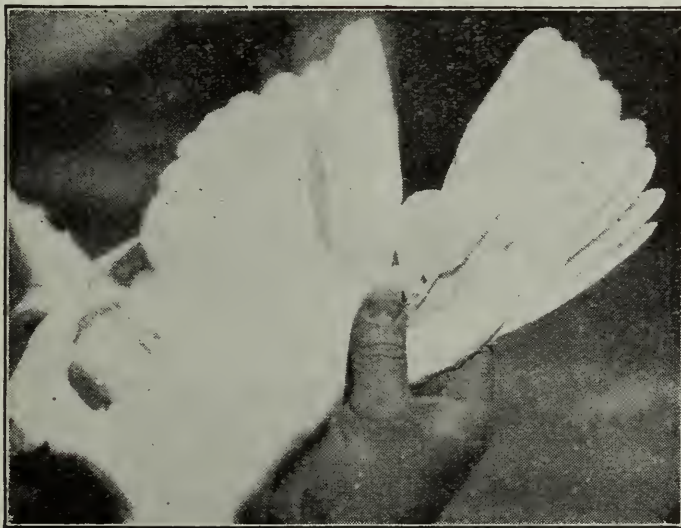
When the hen ceases laying the colour immediately commences to reappear. The colour first returns to the vent, then to the eye ring, a yellow area then proceeds down the beak in the same manner as the white area did previously, and this is followed by similar changes in the shanks. Any hen showing extensive pigmentation during the Spring or early Summer suggests either poor production or a prolonged rest period and such a bird should be viewed with suspicion. Short rest periods, such as broody periods, often result in a band of yellow showing in the beak, preceded and followed by a band of white.



A



B



C

Fig. 40. Wing Mould.

A—First primary moulted and in, second primary moulted and partly grown.

B—A pair moulted at the same time, one broody period.

C—A duplicate of A.

This indicates that during the time required for the broodiness to be broken up, the bird replaced some yellow pigment, which again was followed by bleaching when laying commenced.

When a hen is broody during the Summer she usually moults one of the primary feathers in each of her wings. This moult commences next to the small axillary feather at the division of the wing. Fig. 40 shows wings outspread. The flight feathers are divided into two sections, the primary and the secondary. On her first broody period the hen may moult the first primary and a new feather will grow in. On each succeeding period of broodiness another feather may be moulted and a new one will take its place. In the illustration the hens have had rest periods, as shown by the new feathers. The complete section of primaries contains nine or ten feathers, so by counting these and taking note of any new feathers growing in, the number of rests a hen has taken can be fairly accurately determined. A hen showing a tendency to spend much of her time in brooding can well be removed from the flock as her production will not be high.

Temperament. There is much difference in the temperament of individual hens. Almost invariably the heavy layer is quite docile and does not object to handling. She will rest quietly and contentedly in one's hands while being handled. The poor layer has a disposition quite in keeping with her head type. She is wild and noisy, the quiet behaviour of the good hen being replaced by squawking on the part of the cull. These same differences can be noticed in the actions of the birds in their pens. The heavy layer is always going about, busy but contented. She is among the first off the roost in the morning and is late in going to rest at night.

The Time to Cull Hens. It is recommended that the culling be done during the latter part of April, May or early June. At this time of the year the heavy Spring production is almost over and the poorer members of the flock will soon be ceasing to lay. The meat price of hens is still good. Later on during late July and in August, the early moulters should be noted, removed and disposed of. It is, however, not necessary nor desirable to allow poor birds to remain in the flock until Spring or Summer.

The most intelligent culling programme is the one which calls for the removal of undesirable birds at any time of the year. The careful poultryman will keep a close watch at all times for outstanding boarders and immediately dispose of such. It must be borne in mind that every unproductive bird may offset the profit of a productive one, with the result that neither returns a profit to the owner.

Marketing the Culls. Where one general culling a year is done the hens can easily be graded into three classes. The good performers can be banded and left in the pen and real culls crated and sold. There are, however, a number of hens which are still laying, though of poor type and which will not be desirable birds to hold over another season. These can be temporarily marked, kept until they have ceased laying and then sold. A good method of marking these birds is to cut off their tails. This makes them easily identified when it is desirable to dispose of them.

The following chart, developed by the Poultry Department of the Kansas Agricultural College, Manhattan, Kansas, summarizes the points taken into consideration in the instructions for culling chickens.

Judging for Present Production

CHARACTER	LAYING HEN	NON-LAYING HEN
Vent	Large, dilated, oblong, moist.	Small, contracted, round, dry.
Pubic bones	Flexible and wide apart.	Rigid, close together.
Comb	Large, red, full, glossy.	Small, pale, scaly.
Wattles and lobes	Prominent, soft, smooth.	Inconspicuous, rough, dry.

Judging Past Production

CHARACTER	LONG-LAYING PERIOD	SHORT-LAYING PERIOD
Vent	Bluish white.	Flesh coloured.
Eyelids	Thin and edges white.	Thick, yellow tinted.
Eye	Prominent, keen, sparkling	Listless, sunken.
Earlobes	Enamel white.	Yellow tinted.
Beak	Pearly white.	Yellow tinted.
Face	Clean cut, sunken.	Full, well fleshed, yellowish.
Shanks	White, flat, thin, creased.	Yellow, round, smooth.
Plumage	Worn, soiled, lifeless, close-feathered.	Signs of moulting, loose-feathered.

Judging Rate of Production

CHARACTER	HIGH RATE	LOW RATE
Keel	Slopes downward.	Slopes upward.
Pubic bones	Tips thin, point straight out.	Tips thick, curved in.
Capacity	Four to five fingers.	Two fingers.
Abdomen	Soft, pliable, dilated.	Fatty, hard, contracted.
Rump	Broad, width carried back.	Narrow, cramped.
Lateral processes	Prominent, pointed outward.	Hard to find, pointed inward.
Skin	Soft, thin, loose, silky.	Thick, dry, underlaid with fat.

MARKETING POULTRY PRODUCTS

The only fair method to both producer and consumer is the sale and purchase of eggs and poultry on a graded basis. The producer of a first-class product should get the best price and the consumer should know what he or she is buying.

The establishment of definite legal grades has changed the marketing conditions in many parts of the Province. The regulations governing the grades of poultry and eggs are under the direction of the Dominion Live Stock Branch and information relative to them will be gladly furnished to parties writing the Live Stock Commissioner in Ottawa.

Poultry and eggs are good food. For some unknown reason the average Canadian does not consume very much poultry meat. The consumption of eggs is relatively high in Canada but it has not by any means reached its maximum.

In the producing sections situated away from centres of consumption, the securing of a price commensurate with the actual value of the product, or its cost of production, is a problem. There are two factors that will assist in solving the problem; one is for the buyer, whether dealer or grower, to buy the produce on a quality payment basis; and the other is selling through Co-operative organizations. Which is the better method depends entirely on local circumstances. A Co-Operative Society, situated away from large local markets, when well managed should be the better method;

on the other hand payment on the basis of quality is simple and just. These problems can best be solved by the producer and dealer getting together. Co-operative buying and selling is the ideal method, but everybody must work together and stay with the organization. It is seldom that a Co-operative Society or Joint Stock Company does not have occasional poor years and unsatisfactory conditions. Success depends on united effort.

MARKET POULTRY

The production of market poultry of high quality has been a profitable business for the past few years. Some poultrymen actually derive a larger return from poultry meat than they do from eggs. This is particularly true where one develops a programme of continuous marketing throughout the year. Frequent and regular culling of the mature stock, plus the young stock in season, makes such a plan possible.

There is difficulty in marketing any produce of low grade. The market prefers a bird well fleshed, well fattened and cleanly plucked. This means that, as previously suggested, the keel blade should not be extremely deep but should be well covered with flesh. The back should show a considerable layer of fat, as well as a good covering of fat over the pin bones and around the wish-bone and breast. The best grades of poultry call for a white fat.

The mass production of broilers under crowded conditions, where little attention is given to properly finishing the birds, has seriously reacted on the general market. Undersized, poorly finished birds spoil the market for good stock and hence everyone loses money instead of making some profit. Bare-backed, crooked breasted, crooked legged chickens are not wanted on the market.

Chickens fatten fairly readily at from two pounds in weight until maturity. Where the males are caponized they fatten more easily at any age. Generally speaking, immature cockerels or birds under five pounds in weight, are comparatively easy to fatten, especially when the weather is cool. More mature males develop spurs, turn blue over the hips and are then graded as stags.

FATTENING CHICKENS

The greater quantity of poultry going on the market today is not properly fatted. The introduction of grading, and the premium price paid for milk-fed A grade should induce the producer to give more attention to the proper finishing of the birds. Chickens taken direct from the range, even where grown under the most ideal conditions, will probably not grade higher than third grade. Such birds if subjected to from two to four weeks of intensive feeding would, in many cases, grade top and, in addition, show very economical gains for the feed consumed.

Birds, to fatten efficiently, must be in good health when placed in the crates. If suffering from colds, roup, worms, or other infections or parasites, they will probably lose rather than gain in weight. Good, thrifty, slightly immature cockerels, either pure-breds, crosses or grades, of such

breeds as Plymouth Rocks, Wyandottes, Rhode Island Reds, Orpingtons, Sussex, Jersey Giants, Dorkings, Games, etc., make economical gains. It is seldom profitable to attempt to feed for roasters such breeds as Leg-horns, Minorcas or birds of similar characteristics, although they make fairly good broilers.

The greatest gains are made during the first two weeks of feeding. Where feeding longer it would be necessary to get a premium price in order to pay for the longer feeding and the slower rate of gain. Birds are fed three times daily.

Crate Feeding vs. Loose Pen Fattening of Chickens

The term "fattening of chickens" has been in use for some time but it does not exactly convey the meaning intended by the feeders of chickens. The object is to improve the fleshing and add just sufficient fat to make the meat cook well. The chickens are not intended to be abnormally fat, yet at the same time carry considerable fat well intermixed with the lean meat.

We have for a number of years conducted experiments with chickens in crates and in loose pens. Several feeders secured equally as good result with birds in crates as with those in loose pens. Two feeders in particular fed birds to better advantage in crates, while one feeder could get slightly better returns, although not always, with birds in pens.

The majority of buyers seem to think that crate-fed birds are much superior to those fed in loose pens. We prefer feeding birds in crates because it takes less room and we believe that we can feed them with less expenditure of labour and get a more even product.

Construction of a Fattening Crate

Fattening crates are made seven feet six inches long, eighteen to twenty inches high, and eighteen inches wide. The crates are divided into three compartments, each holding from four to five birds, depending on the size of the chickens.

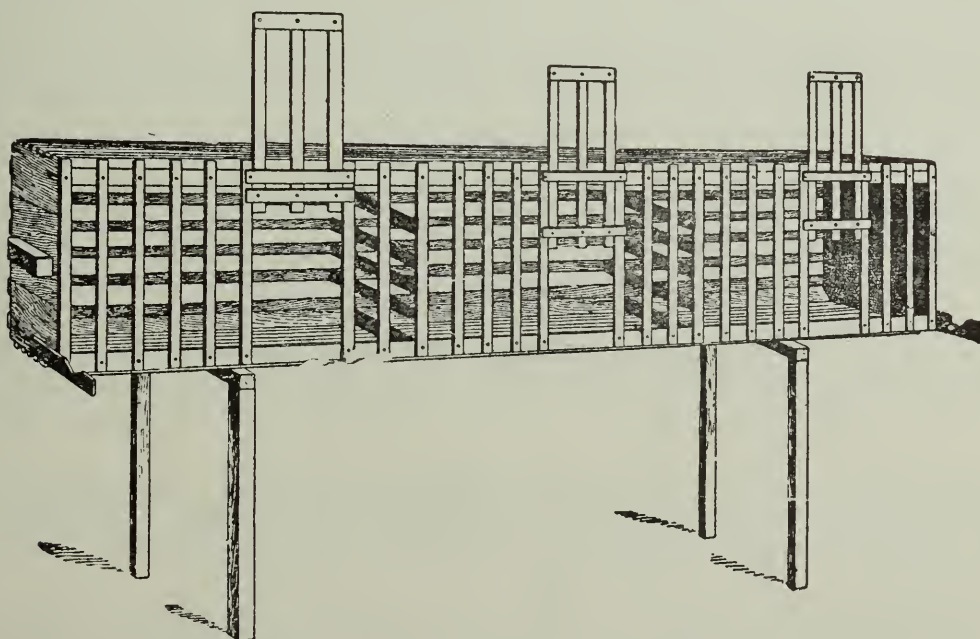


Fig. 41. Showing a single crate or coop.

The crate is made of slats, except the ends and partitions which are solid wood. The slats at the top, bottom and back run lengthwise of the coop and those on the front are vertical. The slats are one and one-half inches wide and five-eighths inches thick. Those in the front are placed two inches apart to allow the chickens to put their heads through for feeding. The slats on the bottom are placed about three-quarters of an inch apart so as to admit of the droppings passing through to the ground. Care should be taken not to have the first bottom slat at the back fit too closely against the back. An opening between the first slat and the back prevents droppings from collecting. The slats on the top and back are two inches apart.

There is a small V-shaped trough arranged in front of the coop for feeding and watering the chickens. This trough is from three to four inches deep and is made of three-quarter inch lumber. Coops may be made from old packing boxes by taking off the front and bottom and substituting slats in their place. During warm weather the crates may be placed out of doors. They need to be protected from the rain by placing a few boards over them. In cold weather the crates should be placed in a house or shed where they are protected from raw, cold winds. When fattening chickens inside of a building it is well to darken the building and keep the birds as quiet as possible.

After each lot of birds is killed the crates are painted with some liquid lice killer. Coal-oil and carbolic acid are very good. Use one gallon of coal-oil to one pint of crude carbolic acid. We have used some of the prepared mixtures with good results. If the birds are lousy when put in they should be well dusted with Sodium Flouride, or other insect powder. Some people use sulphur but when this material is used care should be taken not to use too much as an excess may produce a scaly condition of the bird's skin. Lousy birds do not fatten economically and are unpleasant to pluck. Dust again twenty-four hours before killing.

The birds should be watered at least twice every day in warm weather. Grit should be given them twice a week.

How To Feed

We have received a number of enquiries as to how to feed birds that are being fattened, and the exact amount of feed to give each day. In answer to these enquiries, a sample feeding schedule is here given.

Birds brought in from the range should be starved for about twenty-four hours, during which time water may be given. They must be fed lightly at first, giving only what will be eaten up in about ten minutes. As the amount fed is increased the time for feed is also increased until at the end of the feeding period they are allowed from twenty to thirty minutes in which to feed. Any feed left in the troughs after the specified time should be removed.

Table No. 24 shows amounts fed morning and evening to two lots of four birds each. The first lot shows steady increase in amount fed, while the second shows irregular increase.

It is difficult to give a ration suitable for fattening chickens that meets the requirements of every individual. One has to use whatever feeds

TABLE NO. 24

LOT No. 1					LOT No. 2				
Dates	Morning		Evening			Morning		Evening	
	Meal	Milk	Meal	Milk		Meal	Milk	Meal	Milk
Oct. 10	oz.	oz.	4.25oz.	6.25oz.	oz.	oz.	5.0 oz.	7.5 oz.	
" 11	5.0 "	7.5 "	5.5 "	8.25 "	5.0 "	7.5 "	6.0 "	9.0 "	
" 12	6.0 "	9.0 "	6.5 "	9.75 "	6.5 "	9.25 "	6.0 "	9.0 "	
" 13	7.0 "	10.5 "	7.0 "	10.5 "	6.0 "	9.0 "	5.5 "	8.25 "	
" 14	7.0 "	10.5 "	7.0 "	10.5 "	6.0 "	9.0 "	6.5 "	9.25 "	
" 15	7.5 "	11.25 "	7.5 "	11.25 "	6.0 "	9.0 "	5.5 "	8.25 "	
" 16	7.75 "	11.75 "	7.75 "	11.75 "	6.0 "	6.0 "	6.0 "	9.0 "	
" 17	8.0 "	12.00 "	8.25 "	12.00 "	6.5 "	9.25 "	7.0 "	10.5 "	
" 18	8.5 "	12.25 "	8.75 "	13.00 "	8.0 "	12.00 "	8.0 "	12.0 "	
" 19	9.0 "	13.50 "	9.25 "	14.00 "	8.0 "	12.00 "	9.0 "	13.5 "	
" 20	9.5 "	14.25 "	9.75 "	15.75 "	10.0 "	15.0 "	10.0 "	15.0 "	
" 21	10.0 "	15.00 "	10.25 "	15.25 "	10.0 "	15.0 "	9.0 "	13.5 "	
" 22	10.5 "	15.50 "	10.75 "	16.00 "	9.0 "	13.5 "	9.0 "	13.5 "	
" 23	11.0 "	16.50 "	11.25 "	16.75 "	10.0 "	15.0 "	8.0 "	12.0 "	
" 24	11.25 "	16.75 "	12.00 "	18.00 "	10.0 "	15.0 "	10.0 "	15.0 "	

are available and for that reason we are giving several rations that have generally proven satisfactory. The grains in a ration should be ground as finely as possible and mixed with milk to the consistency of a pancake batter, so it will pour. Usually better results are secured when the feed is mixed twelve hours prior to feeding.

It is of the utmost importance that the birds be kept with keen appetites as a little over feeding at the beginning usually results in indifferent gains.

Fattening Rations

Equal parts, by weight, of ground oats (with the hulls sifted out, or ground oat groats, or oat middlings), white hominy and ground wheat. This is mixed with thick, sour milk, or where milk powder is used add twenty per cent to the grain mixture.

The hominy and oats improve the palatability of the ration and help in the production of fat. Meat meal may be used in the place of the milk but does not produce as good colour of fat, nor as satisfactory gains.

Another very good ration is composed of two parts of finely ground oats, two parts finely ground buckwheat and one part of finely ground corn, moistened with sour milk.

The ration we are using at present, with very good results, is composed of 100 pounds white hominy, 50 pounds each of ground barley, oats and wheat. To this 250 pounds we add 36 pounds of powdered milk, about 2 pounds charcoal, and $\frac{1}{2}$ pound of salt. This is moistened to rather a wet state, but not sloppy, and is fed what the birds will eat up clean in fifteen minutes.

Any feeds that are palatable and well mixed, so that the meal will stay in suspension with the milk, will give, in most cases, reasonably good results. It is not advisable to use only one kind of cereal.

KILLING AND DRESSING POULTRY

All birds should be fasted for twenty-four hours before killing, and during the period of fast be given some water to drink. If this is not done any feed remaining in the crop and intestines at the time the bird is killed decomposes. As a result of this decomposition, strong smelling gases are liberated which taint the flesh of the bird, not only destroying its flavour but very seriously lowering its keeping qualities.

All birds should be killed by bleeding, preferably through the mouth. This is a very simple operation and a little practice will ordinarily make one fairly proficient at this work. Two general methods of handling the birds are used; the one is to place the bird on a padded bench or table,

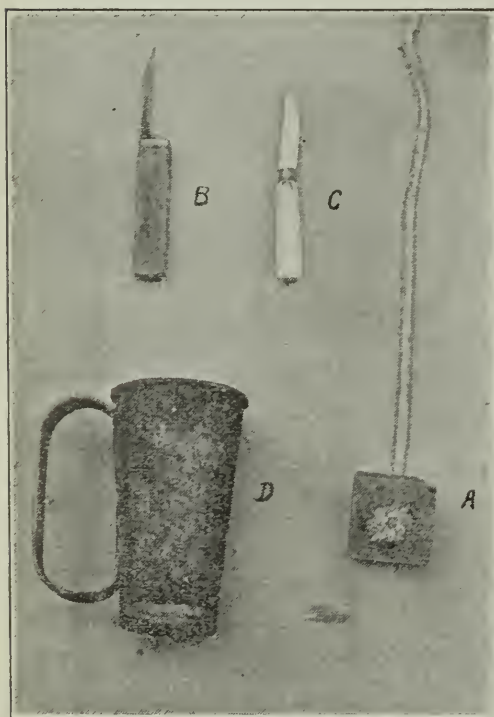


Fig. 42. Killing and Plucking Equipment—(a) Rope and block for hanging bird up; (b) Killing knife; (c) Pinning knife; (d) Weighted blood cup.

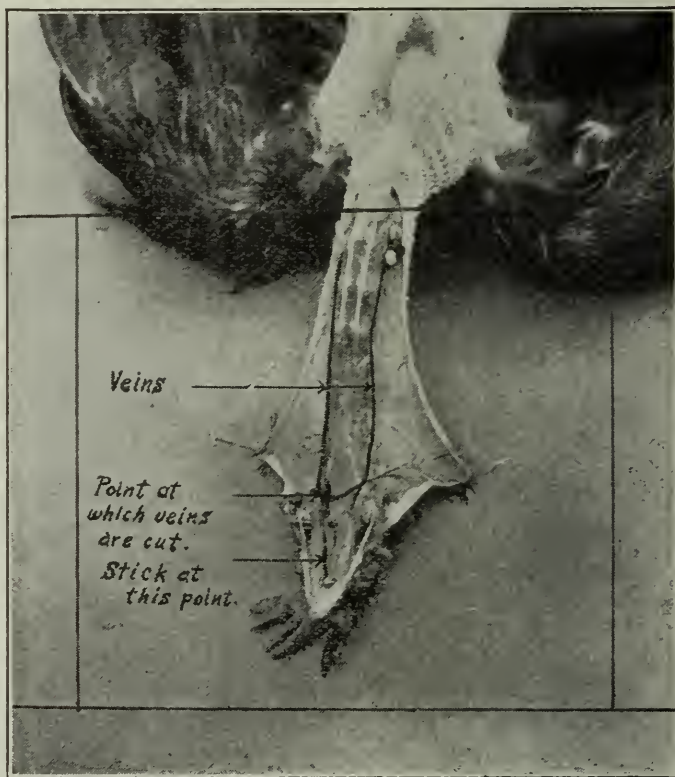


Fig. 43. Anatomical view of neck showing the location of veins, also the cleft in the roof of the mouth where bleeding and braining operations are performed.

and the other is to hang the bird up by the feet with a rope or cord. For the average person the latter method is preferred as with it there is less danger of bruising or barking the skin than where the bird is lying upon some object. The one end of the rope or cord may be fastened to a small rod or pole and to the other end is attached a small block about two inches square, as shown in Fig. 42, A.

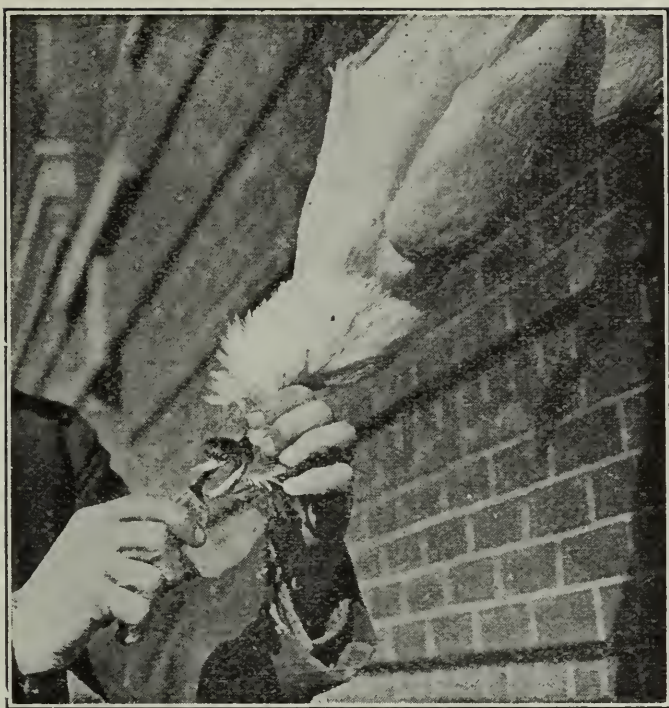


Fig. 44. Bleeding operation.

When hanging the bird up, the end of the rope which is attached to the block is placed around the feet and the block dropped in between the bird's feet and the rope. This holds the bird without tying and should be so adjusted that the bird's feet are about on a level with the picker's shoulders.

For bleeding, a sharp knife with a blade about three inches in length is most satisfactory. A regulation killing knife is shown in Fig. 42, B. To bleed, catch the bird's head with the thumb and forefinger just at the juncture of the neck and head, or at the ear-lobes as shown in Fig. 44, then with the third finger open the chicken's mouth. Next insert the knife and pass it down the throat practically the full length of the blade, then with the edge of the blade turned downward, cut rather heavily with a drawing stroke of the knife. The object is to sever the jugular veins at the point where they unite at the left side of the throat, as shown in Fig. 43.

The bird should bleed freely if the cut is made at the proper point. Next, turn the blade of the knife over and insert the point of the blade in the slit or groove in the roof of the mouth, as shown in Fig. 43, and then quickly push backward so as to pierce the brain. If the back of the knife is kept in a line with and touching the point of the bill, the blade will pierce the brain. One can tell when this is done because the bird will squawk. If it does not squawk the brain is not pierced, which means tight feathers and hard plucking. As soon as the sticking operations are completed attach a blood can at the lower bill. This catches the blood, thus preventing it being thrown about, and the can being weighted tends to hold the bird still. For a blood can any small can to which a hook can be attached will answer the purpose. In Fig. 42 D, is shown a style of blood can which is used extensively in the packing houses. In this can the hook is solidly attached on the inside, near the handle. The can is weighted with three-quarters of an inch of lead in the bottom. Cement or a small stone will answer the purpose just as well.

The chicken should be plucked immediately, first removing the long wing feathers and tail feathers, then the feathers on each side of the breast, those on the legs, and lastly those on the back. Do not try to pull the feathers either forward or backward, but somewhat sideways or at an angle. The rough or coarse feathers should be removed in the shortest time possible, as the more quickly the feathers are removed after sticking the easier they will pull and the less danger there is of tearing the skin. In removing the wing feathers for instance, grasp both wings in the left hand and the feathers of both in the right, removing them all at one stroke of the right hand. Next, raise the right hand to the tail, grasping tightly all the feathers in the tail, and with a slight twist remove with a second stroke of the right hand, and so on over the different sections of the body. To remove the pin feathers use a dull bladed knife, similar to an ordinary paring knife, Fig. 42, C. Be careful not to rub or bark the skin. This may be done very easily by rough handling, or by placing the chicken in contact with coarse clothing, hence do not place the chicken on your lap to pluck it. If you should unfortunately tear the skin, hold the skin at the torn part tightly to the body between the thumb and first finger, and then remove the rough feathers near the torn spot. Anyone, with a little practice, can entirely remove the rough feathers from a bird in from three to five minutes. Expert pluckers will do it in from three-quarters of a minute to one minute.

The bird should be plucked clean, the blood washed from the head and out of the mouth, and the feet washed clean.

The cooling rack, Fig. 45, allows free circulation of air around the birds, resulting in more rapid cooling, which in large packing plants is very important. In such places we find the cooling rack in common use.

Many good chickens are spoiled by being packed before they are thoroughly cooled. Care should be taken to see that all the animal heat is out of the body before they are packed. We find it advisable to cool the birds at least twelve hours before packing them.

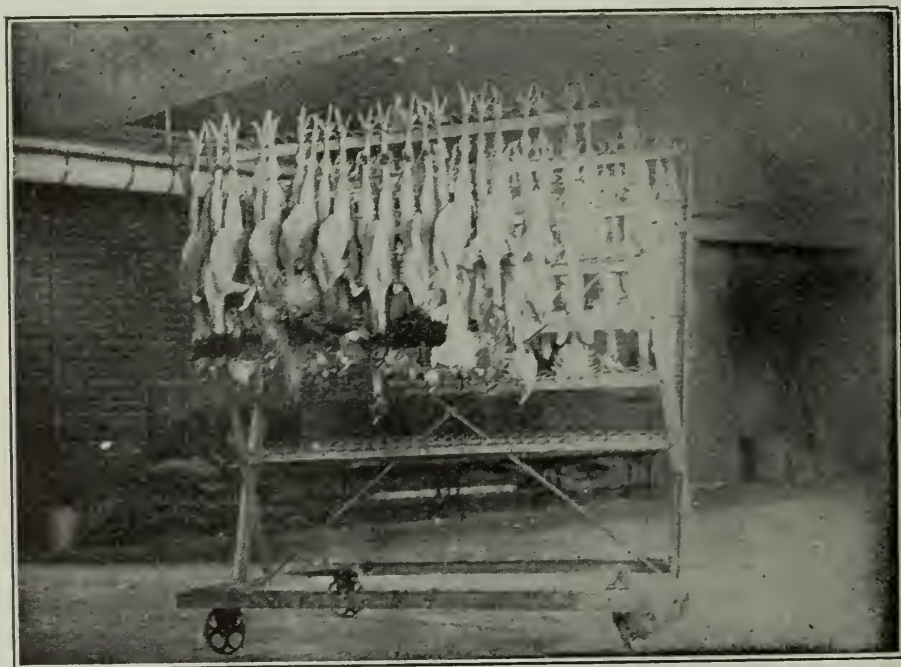


Fig. 45. Cooling Rack.

In packing for shipping, they should be packed in boxes holding one dozen birds to the box. The size of the box varies with the grade or size of chickens placed in them, but should be such that when the chickens are packed they are absolutely tight so that there is no possibility of them shaking about and becoming bruised. The boxes are best made of bass-wood or similar wood, free from odour, as otherwise the flesh of the birds will absorb the odour, tainting the flesh. The box is lined with parchment paper and, if the chickens are to be shipped a long distance, each bird is also wrapped in parchment. This prevents the chickens bruising each other and, at the same time to a considerable extent, checks decomposition. Do not use ordinary wrapping paper as it absorbs dampness and will cause the chicks to become clammy, which makes them unsaleable.

The dimensions of some of the boxes are: For broilers weighing about 24 lbs. per dozen, 16 inches by 15 inches by 3½ inches, inside measurement. This is where they are packed in single layer with the breast up and the legs extended. For chickens weighing thirty-six to forty-two pounds per dozen a box 23 inches by 15½ inches by 4 inches, inside measurements, would do. For one dozen roasters weighing four to four and one-half pounds each, a box 32 inches by 19 inches by 4 inches, inside measurements; and for heavy roasters weighing five to five and one-half pounds each, and packed single layer, a box 33 inches by 20 inches by 4¼ inches, inside measurement. The material used varies in thickness from one-quarter inch for sides, bottom and top, and one-half inch for ends in the smallest size boxes, to one-half inch for sides, top and bottom and seven-eighths inch ends in the largest boxes.

(The writers wish to acknowledge the use of POULTRY PACKERS' GUIDE in preparation of box dimensions above stated, for which credit is hereby given.)



Fig. 46.



Fig. 47.

Showing Good (46) and Poorly Fleshed (47) Birds.

MARKET EGGS

There appears to be a general idea that the shell of an egg protects the contents against all kinds of contamination and temperature variations and that while the outside of a shell may be dirty the interior is not affected by such conditions. Such an idea could not be farther from the facts.

Factors Affecting Egg Quality, Flavour and Palatability

Eggs are a very perishable food—just as perishable a food as milk. Perhaps we do not realize this because nature gives us eggs already done up in a package, the shell, and we cannot see the deterioration taking place as we can in other foods. But this container, the egg shell, is of a porous material and as a result air can readily pass through it, evaporation may take place or strong odours may penetrate it and affect the flavour of the egg.

Milk deteriorates quickly if left around at ordinary room temperature of 70 degrees F. This is also true of eggs. Eggs will rapidly deteriorate in palatability, in flavour and in poaching qualities if left at such a temperature.

The following tests, made at the Macdonald Institute in co-operation with the O.A.C. Poultry Department, definitely show how the egg declines in palatability under unfavourable conditions, and how a strong odour may affect the flavour of an egg.

Some eggs were kept in a refrigerator at 50 degrees F; some were left at room temperatures (which ranged from 69 to 76 degrees F.); and some were exposed to a strong tar odour. These eggs were tested frequently for:

1. Flavour—by cooking the egg in the shell, chipping off the top and testing the egg as soon as it was cooked;

2. Poaching Qualities—by poaching the egg. The flavour of these eggs was also noted.

The following are the results of these tests:

THE EGG AND ITS TREATMENT	RESULTS OF THE TESTS FOR	
	FLAVOUR	POACHING
Fresh May eggs, exposed to a strong tar odour, tested when less than 24 hours old	Strong Tar Flavour, especially in yolk	Excellent appearance but a strong tar flavour
Tested when 5 days old	Still a strong tar flavour	
Fresh May eggs, held in refrigerator at temperature of 70 degrees F.		
1 day old	Excellent	Excellent to good
2 " "	Excellent	Excellent to good
3 " "	Good	Good
5 " "	Good	Good
6 " "	Good to fair	Fair to good
9 " "	Fair	Fair
10 " "	Fair	Poor
Fresh May eggs, held in refrigerator at temperature of 50 degrees F.		
1 day old	Excellent	Excellent
2 " "	Excellent	Excellent
3 " "	Excellent	Excellent to good
5 " "	Excellent to good	Excellent to good
6 " "	Excellent to good	Excellent to good
9 " "	Excellent to good	Good
10 " "	Good	Good

Putting the whole thing into a nut shell, these are the facts:

1. Strong odours will pass through the shell and spoil the flavour of eggs;
2. The longer eggs are held, the GREATER the decline in flavours and poaching qualities;
3. The higher the temperature at which eggs are held, the more RAPID the decline in flavour and poaching qualities.

It is very desirable that eggs for household use have good flavour and poaching qualities since the homemaker uses eggs so much for table purposes. According to a very limited amount of data which we have collected by means of questionnaires (questionnaires were sent out through the Home Economics classes of the Consolidated School and the Guelph Collegiate and Vocational Institute) more than two-thirds of the eggs used were for table purposes—boiled, poached, raw in drinks, fried, scrambled or in omellettes—purposes which necessitate the use of an egg of good flavour and poaching qualities in order to obtain satisfactory results.

And so, whether you be a producer of eggs, a dealer, or a consumer, why not give the eggs the care which you give any other perishable food? Keep eggs in a cool place, free from all odours, just as you do milk, butter, etc. The producer will find such precaution well worth while since it helps preserve the quality of his product. The dealer will also find it to his advantage to give eggs proper care so that his customers will be pleased with the quality of such eggs and will come back for more. It is also advisable for the consumer to keep eggs in a cool, clean place in order to preserve the palatability of the eggs from the time they reach the kitchen until they are used.

Other Conditions Affecting Egg Quality

The shell of the egg being porous, we can readily understand how minute animal and plant life may enter the egg shells. For example, egg cases with the fillers, flats and pads may get wet and as a result mould develops. Later eggs are placed in such cases and left for a time with the result that when the eggs are removed, in addition to them having a musty odour and taste, mould growth may actually be found on the inside of the shells.

Many eggs are spoiled by being partially incubated. Most people believe that an egg must be set under a hen or in an incubator before it will commence to hatch. A temperature over seventy-five degrees F. will start embryonic development. Eggs are frequently exposed to higher temperatures for hours and even days in warm weather before they reach the consumer. If such eggs are later subjected to temperatures under sixty-five, the developing embryo dies and the egg is unfit for food. There are numerous ways in which hatching may be started in eggs. Failure to collect eggs frequently during the warm weather, or leaving them over night under broody hens, are common causes, also leaving eggs exposed to the sun or in warm rooms, stores, cars, etc., or even having them in a warm kitchen cupboard.

Removal of the male birds from the flock in warm weather, resulting in the production of non-fertile eggs, would very materially reduce the present losses from partially hatched eggs.

Holding temperatures are also of great importance in preventing loss of quality and a consequent lowering of grade.

Dirty eggs, or even washed eggs, may go bad or be rendered unfit for food due to these conditions. The washing of eggs is not so objectionable if the eggs are used immediately but they deteriorate very rapidly after washing.

The feed that a hen consumes may very materially affect the flavour of the eggs laid. Hens that are forced to forage for most of their living during the summer may produce eggs in which the yolks are dark in colour and strong in flavour. However, hens fed on a properly balanced ration and freely exposed to direct sunlight, produce eggs of good quality that may be considered of superior nutritional value.

POULTRY HOUSING

The proper housing of poultry is an essential factor of success. This does not necessarily mean heavy expenditures or elaborate structures; in fact it is usually found that the cheaper and simpler houses are the more efficient. The type of building is apparently not so important, as one may find a wide divergency of type giving equal efficiency and economy of operation. It is, therefore, not proposed to lay down any hard and fast rule relative to the type of building, but rather to discuss some of the fundamental principles underlying successful housing.

In order that one may get a true perspective of the whole question it is first necessary to give some thought to the question of location, and to the primary essentials in housing. There are two general classes of poultry houses; those used for laying and breeding purposes and those used for rearing. The former are usually on permanent foundations while the latter are mostly portable. The variation is mainly one of size or type. In order to avoid the possibility of confusion in the mind of the reader the laying or permanent house will be discussed first.

Location of Laying or Breeding Houses

Convenience. Locate houses near the source of supplies. Whether the number of birds to be kept is large or small there will be a considerable amount of feed to transport, hence the nearer to the source of supplies, with due consideration to equally important factors, the greater will be the saving in time and labour.

Exposure. The house should be built facing the South or South-East if possible, as such an exposure will give the maximum amount of sunlight

in the pens. There is also greater protection from the prevailing winds, which are usually from the North or North-West. Full advantage should be taken of any shelter (either natural or artificial) from the prevailing winds as the birds do not take kindly to an exposed location. Bird comfort is closely associated with economic production and any condition which will make the bird more comfortable should receive full consideration.

Soil. The type of soil and the lay of the land are influencing factors in drainage. The ideal soil is one which is slightly rolling and open in texture so that the surface water drains off readily after rains or melting snow. Heavy soils at best drain poorly and hence are unsatisfactory. A damp soil harbors disease.

Drainage. Drainage about the poultry house and yards is of extreme importance. Poorly drained yards aggravate trouble from dampness in the houses and yards. There is also a manifestly increased amount of trouble from disease and intestinal parasitic infestation under such conditions.

Shade. Extremes of temperature lessen production and should be modified in so far as practicable. Dense Summer shade, however, as from the heavy foliage of trees, shrubs or bushes, is not desirable. Such locations do not benefit from the germicidal action of direct sunlight and hence may serve as sources of infection of disease and parasites.

The Primary Essential in Housing

The main essential in housing is bird comfort. The major factors in providing this condition are: (1) dryness, (2) ventilation (3) freedom from draughts, (4) light, (5) floor space. One must of course bear in mind that the cost in relation to providing these factors is important.

Dryness. There are three sources of dampness in the poultry house. A large amount of moisture is exhaled from the lungs of the birds. Moisture sometimes enter the house through a badly constructed floor. Considerable water is also spilled by the birds while drinking. It matters not from what source the moisture comes, if allowed to accumulate in the pen it will gradually lower the vitality of the stock, decreasing production and possibly causing disease. The trouble is usually more marked in the Fall and Winter than during other seasons of the year. Where moisture is not entering the house through the floor or from drip about the drinking dishes, the trouble will be found associated with lack of ventilation.

Ventilation. It is necessary to ventilate in order to secure dryness, pure air and a proper temperature. Bad ventilation is indicated by frost on the walls or the ceiling and by a foul atmosphere. A greater amount of moisture, pound for pound live weight, is exhaled from the lungs of the birds than from any other class of stock. The ventilating system must remove this moisture from the pen, provide fresh air, and do so without producing draughts in the house. Cotton curtains, window shutters and open-front houses are now most generally used, with the cotton

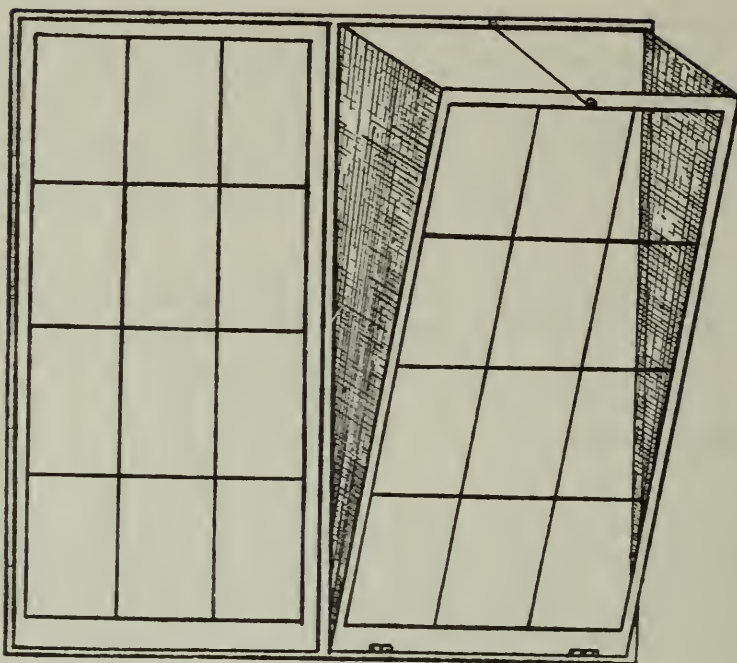


Fig. 48. Window arranged for ventilation purposes.

curtain either in conjunction with or without the straw loft proving most popular. Curtains must be adjusted from time to time to meet varying weather conditions and unless one is prepared to do this better results will no doubt be secured from the use of the open front house.

In Fig. 48 is shown a cut of a window adjusted for ventilation purposes. The window is six inches from the ceiling and eighteen inches from the floor. It is hinged at the bottom, and the opening at the top is adjusted with a cord. Cotton or boards may be placed along the sides of the open window. This device does not interfere with the light, is not attended with floor draughts, and gives fair ventilation. It is suitable for the alteration of some house now in use but which is not at present giving satisfactory ventilation. The alteration can be made at a very small cost, and may be preferred by some to curtains.

Draughts. There is perhaps no condition in the poultry house that is responsible for more trouble and mortality than draughts. This is particularly true if the birds are in a draught while on the roost. Draughts chill the birds making them uncomfortable and, therefore, unproductive. They are also a contributing factor in the production of such diseases as colds, roup, rheumatism and kindred ailments in the flock, which may result in heavy mortality. In constructing the house every effort should be made to eliminate draughts. The sides and back of the house should be absolutely tight and with ventilation from an open front, or curtains, little difficulty will be experienced.

Light. Sunshine is the best germicidal agent in existence. It is therefore advisable to make provision for the admission of as much direct sunshine into the pen as possible. This is especially important during the Winter and openings should be so placed in the front of the house that they will admit a maximum of sunshine. The value of direct

sunshine in the hen house is now becoming more and more appreciated, both from the standpoint of its effect upon the general health of the birds and also because of its effect upon the hatchability of the eggs. This action of direct sunshine is due mainly to the ultra violet rays. These are largely filtered out as the sunshine passes through ordinary window glass.

Floor Space. Over-crowding is a common fault. The practice reacts adversely upon every phase of production and predisposes to disease. The floor space requirement determines the capacity of a pen or building and it is therefore necessary to carefully determine the capacity of the pen and then regulate its population accordingly. Floor space requirement will vary with the size of the pen, the type of building, and the breed of birds. In small pens the floor space allowance is greatest, being possibly as high as six square feet per bird. Increasing the size of the pen permits a reduction in the per bird floor space requirement, with a minimum in even the largest pens of three square feet. The more open the building and the smaller the breed of fowl the greater is the capacity of a given house or pen.

The per bird cost of construction is important. This should be kept as low as possible, consistent with the adequate provision of the essentials.

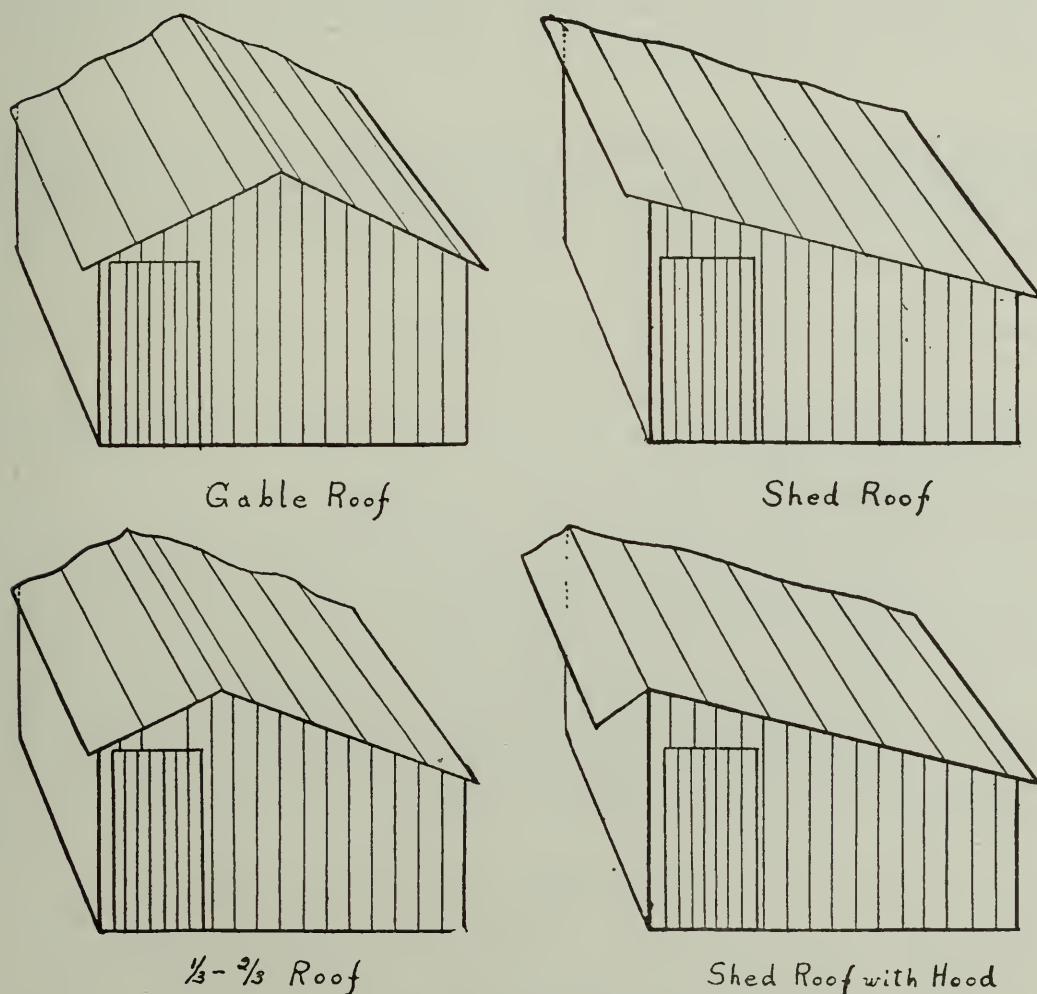


Fig. 49. Roof types.

The two greatest objections to an earth floor are the excessive amount of dust in the pen, and greater trouble with disease control.

It is often possible to remodel old buildings much more cheaply than to build new ones, and still provide efficient accommodation.

Laying or Breeding Houses

Types of Houses. There are two main types of laying houses in general use, i.e., the long or continuous house divided into two or more pens, and the single pen house. Two storey and multiple deck houses are also being used by some poultrymen. There are many points in favour of each of these types as well as numerous objections to each. The long house is no doubt more economical to construct than the single pen house and requires less labour to operate. If separate matings are necessary, yards are required, which mean added expense and close confinement for the birds. This latter point is important where the birds are used for breeding purposes. The single pen house, while costing more than the continuous type, permits of spreading the birds over a large area, making it possible to dispense with yards, and less trouble is likely to be experienced with disease and loss of vigour in the flock. The greatest objection to this latter method of housing is the extra labour required to care for the stock.

Floors. The chief essentials of a good floor are durability, dryness and ease of cleaning. Cement floors are most satisfactory and are easily kept clean. The first cost is possibly high but their durability commends them to general use. Earth floors are more in favour than wood and cost less.

Cement floors for best results should be raised so that the surface of the floor is at least eight inches above the highest elevation of the ground. The intervening space is filled with cobble stones or coal cinders well tramped.

Types of Roofs. There are three principal types of roof construction commonly used in Ontario. These are shown in Fig. 49. It is true that there are other types used but the three mentioned are the best suited to Ontario Winter conditions. The shed or shanty type is no doubt the cheapest to construct. It does not permit of the use of a straw loft which is so important in assisting in the control of moisture in the house during the Winter and in keeping the house cool in the Summer. The gable roof is best adapted to the use of a straw loft and, besides, presents a more attractive appearance, blending in better with the general type of buildings on the farm. Perhaps the greatest objection to the shed roof is the extreme heat of the building in Summer, the temperature at times registering as high as 110 degrees F. This may be overcome to some extent by using a hood on the front. This will of course increase the cost of the building to practically the same point as that of the gable roof.

The two storey house allows the same roof and foundation to give double the housing capacity of a single storey building, without additional cost. It also is a more compact structure and the labour requirement is reduced. Two by six inch studs are required for strength and a gable roof covered with a good grade of asphalt or wood shingles is desirable. The second storey should be just high enough for comfortable head room, while the window and dropping board arrangements for both upper and

lower floors should be similar to those used in the long house. There are a number of farms on which an unused loft or mow can be easily remodeled into a satisfactory fowl pen. In some two storey houses it is difficult to secure satisfactory ventilation. It is usually necessary that the birds on the upper floor remain confined throughout the year.

The flow of air through the poultry house depends largely on the velocity of the wind and upon the difference in temperature between the interior of the house and the outside air. If during cold weather the house is closed up to conserve the heat given off by the birds, the interior becomes damp and frosty. If, on the other hand, the ventilators are left open the warmer air within the house rises, flows out and is replaced by cold air. This results in a house that is too cold for comfort. More feed is therefore used to keep the hens warm and less is left for egg production. In order to secure good results it is desirable then to have the flow of air controlled. During warm weather the reverse condition is present, and the house becomes too warm. It is then necessary to facilitate the rapid interchange of air in order to keep the interior cool. Few, if any, ventilation systems have enough capacity to meet this requirement. It is advisable to have the windows and screens so fastened that they may be opened at such times to assist ventilation. No fool-proof house has as yet been devised. A type of building that gives satisfactory results in one location may be entirely unsatisfactory when built somewhere else. This is a fact that many people fail to recognize.

Many attempts have been made to secure a more even temperature in poultry houses throughout the year. Double walls used either with or without sawdust or planer shavings between them, although satisfactory in some ways, make good shelter for rats. A double layer of boards on the walls with tar or building paper between, is some help. Many houses have

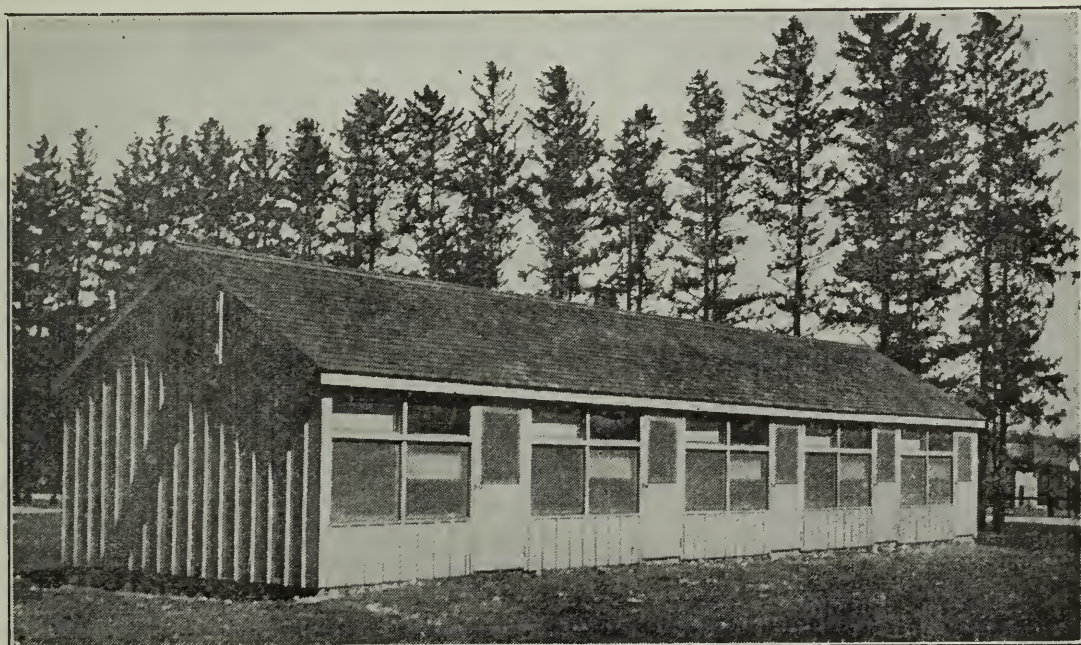
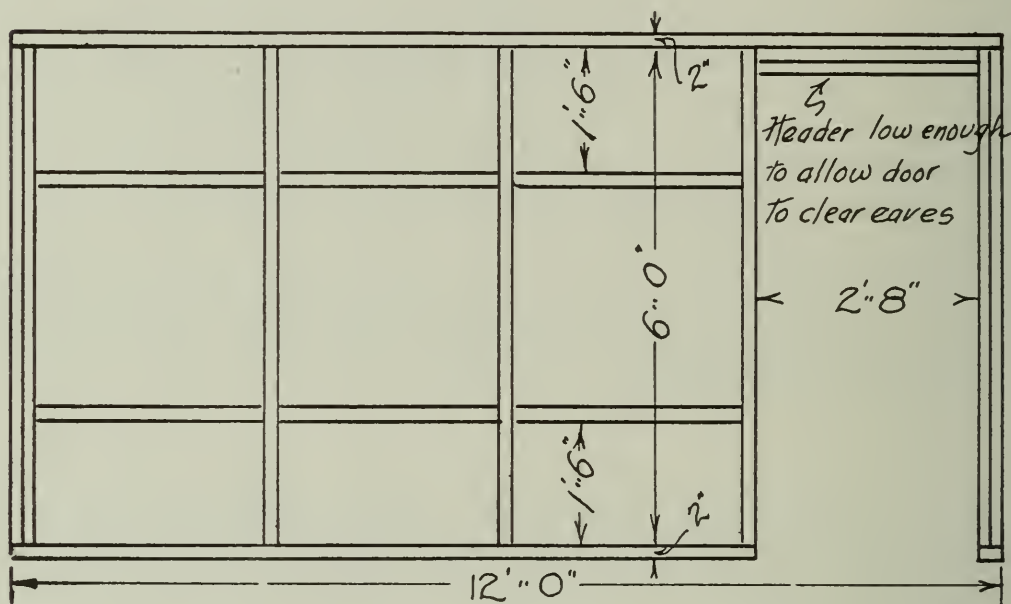


Fig. 50. Poultry Breeding House 12' x 60' with glass substitute windows and cotton ceiling loft.

walls made of a single thickness of siding, covered on the outside with shingles or roofing paper. All of these are more or less satisfactory. Probably the best insulating material now available is made of wood or cane fibre pressed into sheets. This material has very high insulating value and is easily applied. It is sometimes necessary to protect such material near the floor and around the roosts by applying coatings of tar

FRAMING DETAIL for FRONT.



DETAILED CONSTRUCTION of FRONT.

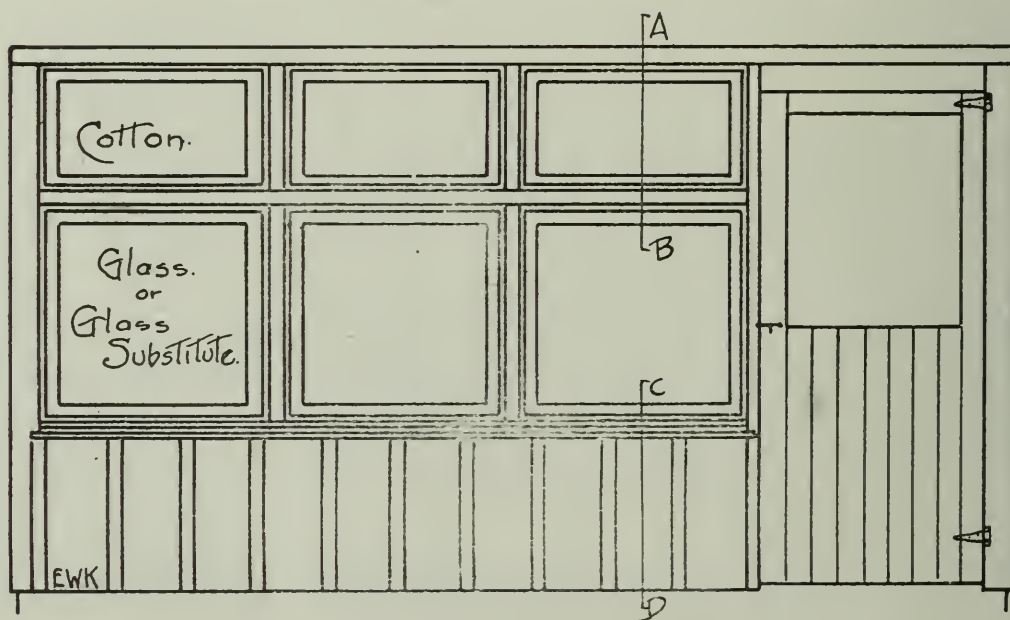


Fig. 51. Plan of house twelve feet in depth which may be fitted with either straw or cotton loft. It may be built one pen or several pens in length, as desired.

or other protective substances to prevent the hens from eating the wall board. Gyproc or similar mineral boards are also used though not of as high insulating value as those made of wood fibre. It is important that the ceiling of the house be insulated as well as the walls. Regulated

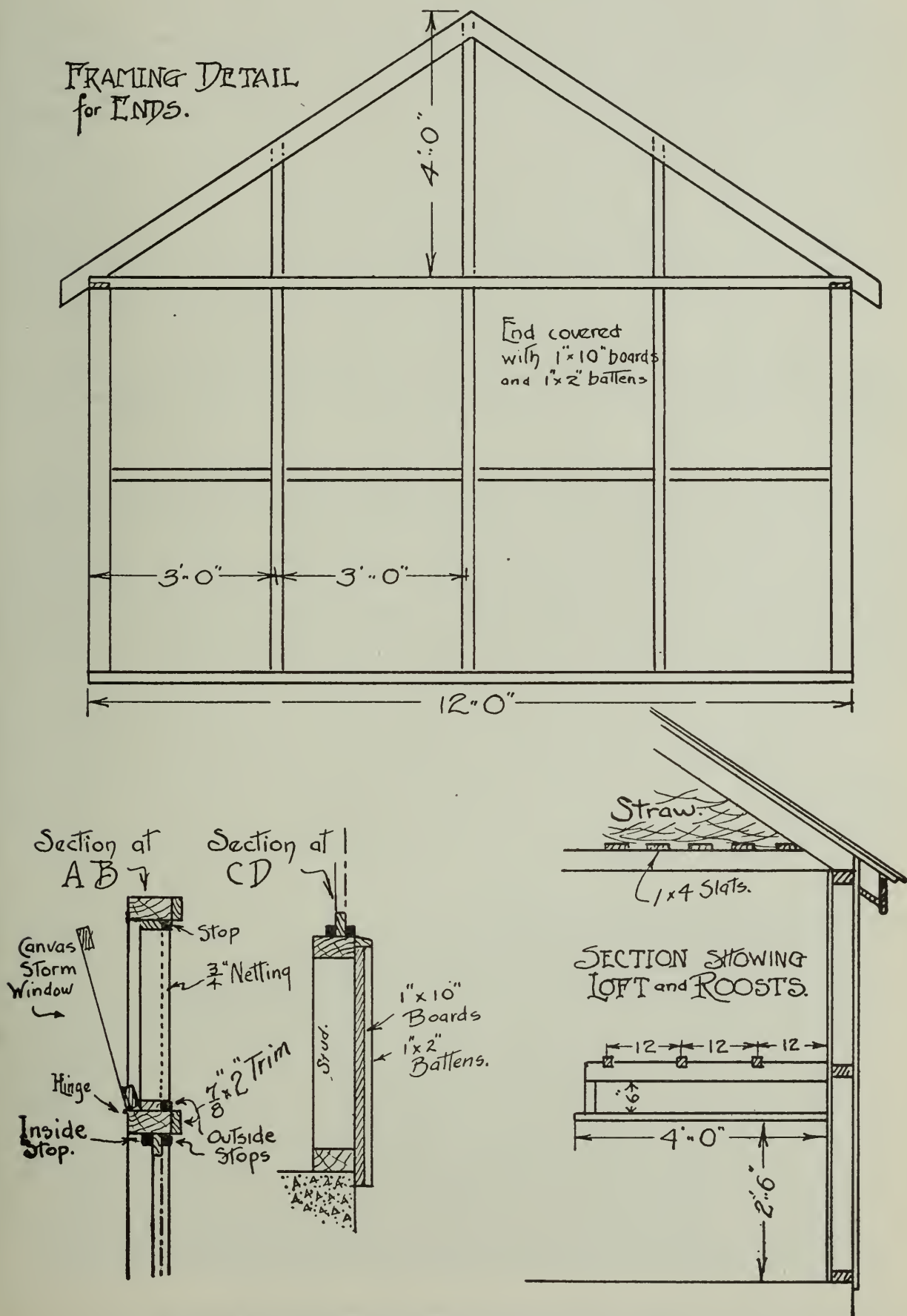


Fig. 52. Framing detail of house shown in Fig. 50.

openings in the ceiling will allow the desired amount of air movement up through the ventilators.

Some poultrymen are heating their poultry houses during the cold weather. This may be done in any one of three or four ways. A brooder stove may be enclosed in a metal box, provided with openings near the top to allow the heated air to flow away freely, and having other openings near the bottom for the cold air to come in. Such an arrangement heats the entire house, is comparatively inexpensive, and can be used fairly satisfactorily during extremely cold weather. Other poultrymen use a hot air system with a graduated heating pipe located at the back of the house below the roosts. In order to secure even heating throughout the house the pipe must be greater in circumference near the heater than at the far end. Hot water heaters with overflow and return pipes located under the roosts and against the back of the house are used in some poultry houses. A satisfactory, controlled system of ventilation is necessary with any method of heating and the house should be insulated to prevent excessive heat loss. It is IMPORTANT to use only enough heat to prevent water from freezing. The supplying of a higher temperature than 45 degrees F. usually results in disastrous moults, with accompanying slumps in egg production.

It must be borne in mind that the cost of heating frequently offsets the value of the feed saved and any increased egg production secured. Unless well ventilated, colds and other respiratory diseases are rather common in heated houses and this may increase mortality. It would seem that a heated, insulated house, that is dry and well ventilated, and that will be comfortable and will maintain a fairly close to optimum temperature throughout the year, is now more or less a possibility.

It is, however, questionable whether the average poultryman can secure a sufficiently increased return from birds so housed to warrant the cost involved. While it may or may not pay him to heat the house, it will usually be worth while insulating the walls and ceiling to conserve the birds' body heat in so far as this is compatible with good ventilation.

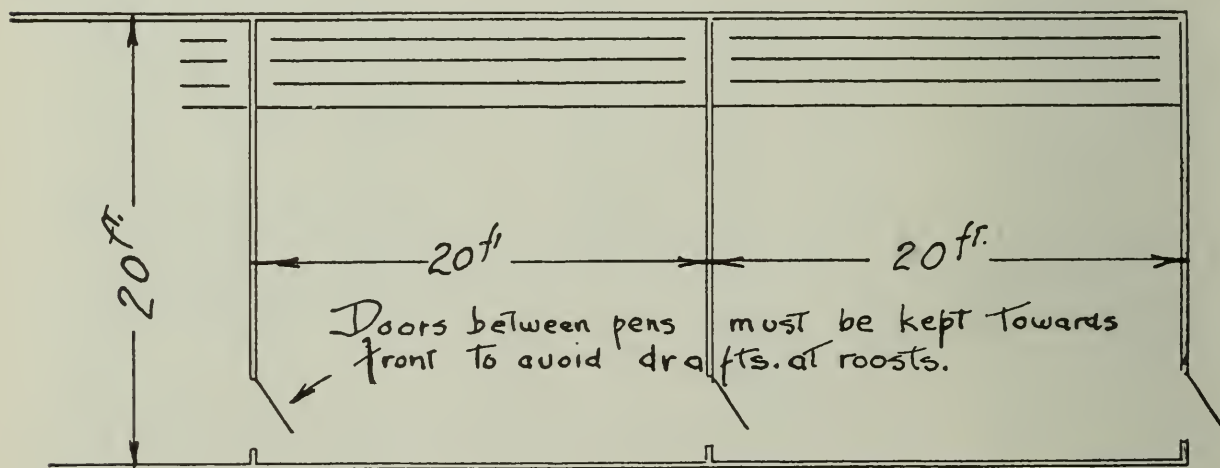


Fig. 53. Showing floor plan arrangement for pens twenty feet square, and the location of partition doors. This idea may be adopted either in Figs. 57 or 59.

Plans and Specifications of College Houses

Because of increased interest in poultry housing throughout the country, we are presenting a type of house which lends itself to a variety of measurements. The plans as submitted show two houses, one twelve feet in depth from front to back, and with twelve foot pens; while the other is twenty feet in depth from front to back, and has twenty foot pens. Either of these houses can be built with any number of pens desired, but maintaining the arrangement and type of construction as shown for the one pen.

The plan of construction of the fronts of these houses is practically identical. The lower section of the front is boarded. Above this is a row of windows extending across the entire front. These are fitted with glass or glass substitutes.

In the case of the latter no sash is required, as the substitute is attached to a frame, as would be done with cotton. Above the glass windows is a row of cotton curtains which are hinged at the bottom, tipping inwards at the top. The plans show doors entering the pens from the front, or a door may be placed at one end of the house, with partition doors in line, which would permit passing from one pen to the next without going out of doors. Two kinds of ceiling construction are used and these are interchangeable. The straw loft has been extensively used in the past and with good results. It assists in the ventilation of the pen, and thus reduces trouble from dampness. Some people object to the straw as being dirty and a harbouring place for vermin. Such trouble seldom becomes serious, but in order to meet this objection a ceiling of cotton has been tried out with very satisfactory results. The cotton is stretched on frames covering the ceiling, and while the first cost is slightly higher

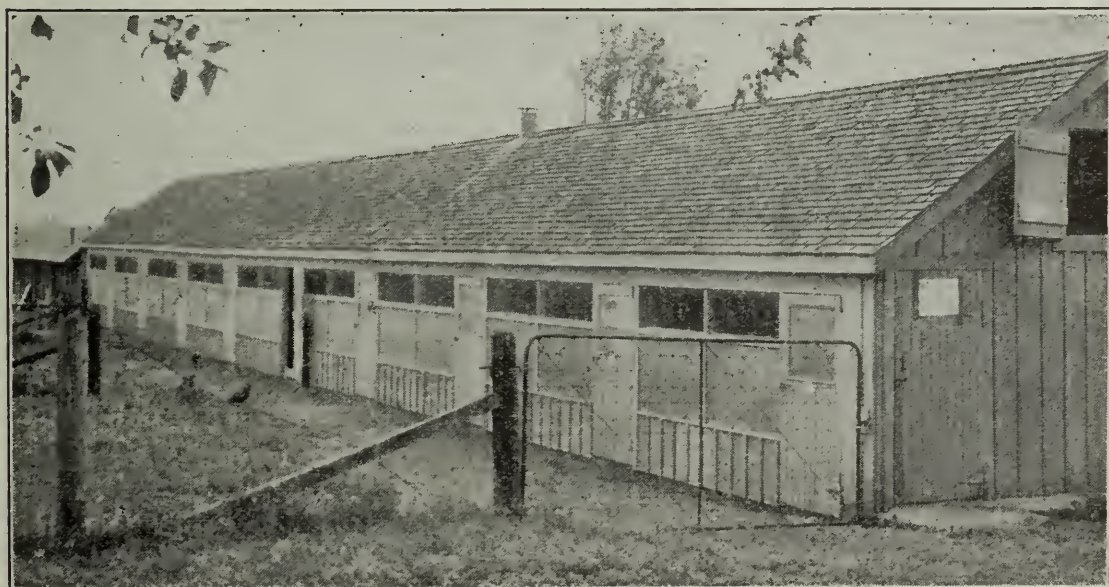
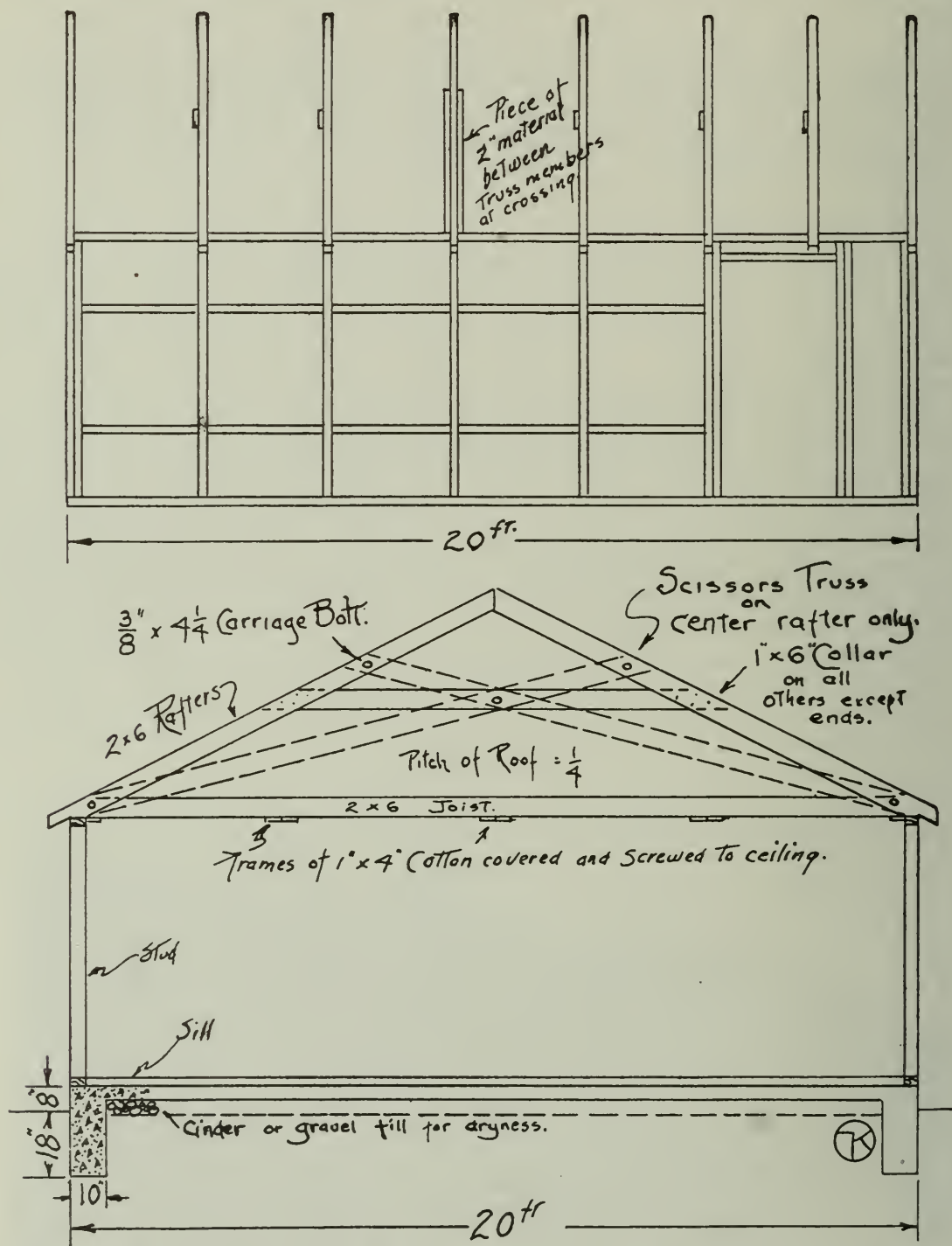


Fig. 54. Laying and breeding house of the long, continuous type, showing arrangement of cotton curtains above glass windows.

than that of the straw loft, the cotton ceiling is white, which gives a brighter, more pleasant appearance to the pen.

The roof of both houses is of the gable type. This allows for more effective use of the loft idea, which results in a warmer house in Winter and a cooler house in Summer, than where no loft is used.

The capacity of the pens presented is important. While the floor space of the smaller pen is over one-third that of the larger, the housing capacity of the smaller pen is actually one-quarter that of the larger.



Detailed dimensions for this house may be taken from the 12' x 12' one.

Fig. 55. Plan showing framing construction for a house twenty feet in depth and a twenty-foot pen, using the same type of construction for the front as in Figs. 51 and 52. House is built with gable roof and for either straw or cotton loft.

The smaller pen will accommodate twenty-five birds, while the 20 x 20 pen will readily accommodate one hundred.

In the operation of these houses, as is the case in any house fitted with adjustable curtains or screens, it requires the constant attention of the operator to secure satisfactory results under all weather conditions. In dull, heavy, humid weather, the adjustment of the curtains would be somewhat different from that which would be most satisfactory in bright, clear, cold weather, or on rough, stormy days.

Open Front House

The question naturally arises: Can a house be constructed that is nearly self-operating, and which will keep the birds in health, and at the same time assure a fair egg production?

Our experience has been that birds thrive best in low roofed buildings, especially so during the winter. We have two houses with the fronts entirely removed except a two-foot wire netting which keeps the birds in, and the sparrows, etc., out. Such houses for this climate must be built low, especially in front, to keep out the snow and wind. It is the writers' opinion that Fig. 56 will meet the needs of the average farmer where he wishes to keep from seventy-five to one hundred hens. While such a building may seem too cold, hens housed in it usually do well, but

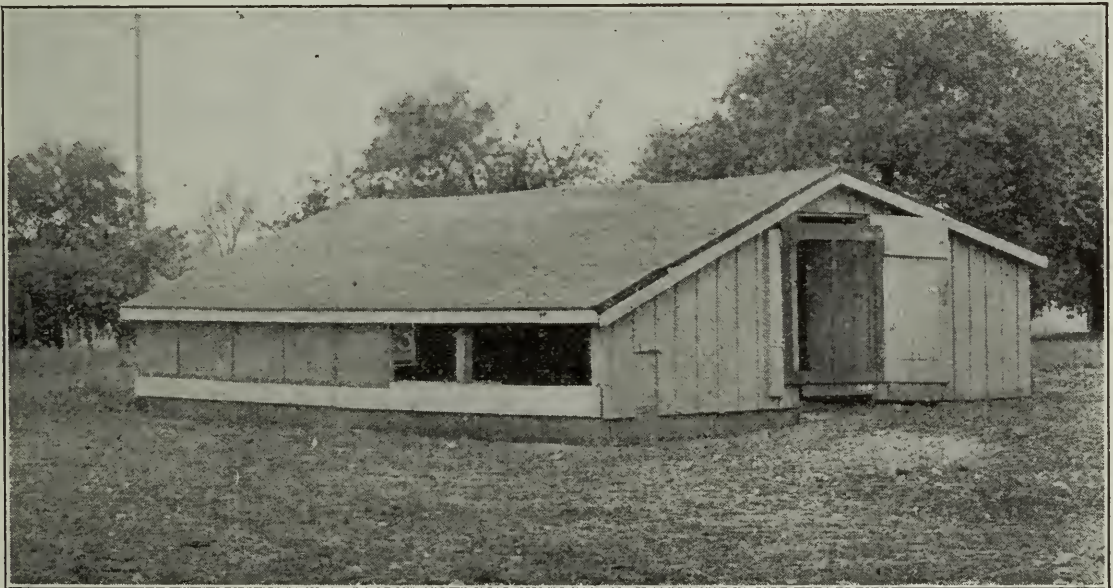


Fig. 56. Open Front House of the 20' x 20' type.

they could possibly be made to lay more eggs during the months of January and February if the house was constructed with cotton screens properly adjusted to meet the weather conditions. Few farmers, however, would be there at the proper time to do the adjusting, hence we use it entirely open, or one-half closed.

The large window in the West, essential for light, should be hinged at the top so that it can be opened during the Summer months, otherwise the house may become too warm.

Bill of Material for Open Front 20' x 20' House

	Number of Pieces	Size	Length
Sill	4	4" x 4"	20'
Plates	2	4" x 4"	20'
Posts			
Back	4	4" x 4"	3' 10"
Front	4	4" x 4"	2' 8"
Cut and erect the above.			
Ends:			
Rafters	4	2" x 6"	12'
Studs	2	2" x 4"	16'
Studs	2	2" x 4"	12'
Girts	2	2" x 4"	12'
Ridge Board	1	2" x 6"	20'
Cut and erect the above.			

Siding	400 board feet 1" 10" S. 4 S.
Battens	250 lineal feet of 1" x 2" S. 4 S.

Put on siding but leave battens until roofing is on.

Rafters	18	2" x 6"	12'
Roof Sheathing	560	board feet of 1" x 8" S. 4 S.	
or better	625	board feet of 1" x 6" Shiplap	
Roll Roofing	5	rolls, 3-ply best.	Do not put on
		until after trim.	

Trim:			
Ends	4	1" x 6"	12'
	4	1" x 3½"	12'
	4	1" x 2"	12'
Front	1	1" x 10"	14'
	1	1" x 10"	8'
	1	1" x 6"	12'
	1	1" x 6"	8'
	2	1" x 6"	12'
	2	1" x 6"	10'
Back	1	1" x 6"	12'
	1	1" x 6"	8'
	2	1" x 6"	12'
	2	1" x 6"	10'

Chicken netting	¾" mesh for front, 3' x 20' piece.
Door	25 board feet of 3½" Pine V joint.

It will be noticed that no dropping boards are used in this building. During the Winter the droppings freeze almost as soon as voided, hence they produce no odour or bad results, and if the house is cleaned every month it will answer very well. We would rather have this condition than dropping-boards covered a foot deep with droppings, as is frequently seen.

A number of houses of this style are in operation in various parts of the Province, and they are giving fair results. In some of the colder sections, such as in the district North of Barrie, the house appears to be too open for severe Winter weather. In such cases we would suggest using movable cotton screens on two sections of the front. The illustration shows three sections, one of which would be open except in extreme conditions of cold or wind.

In some cases open front houses have been built twelve or fifteen feet deep and twenty or more feet across the front. This is not advisable. If there is a direct wind blowing into the house the birds cannot get far

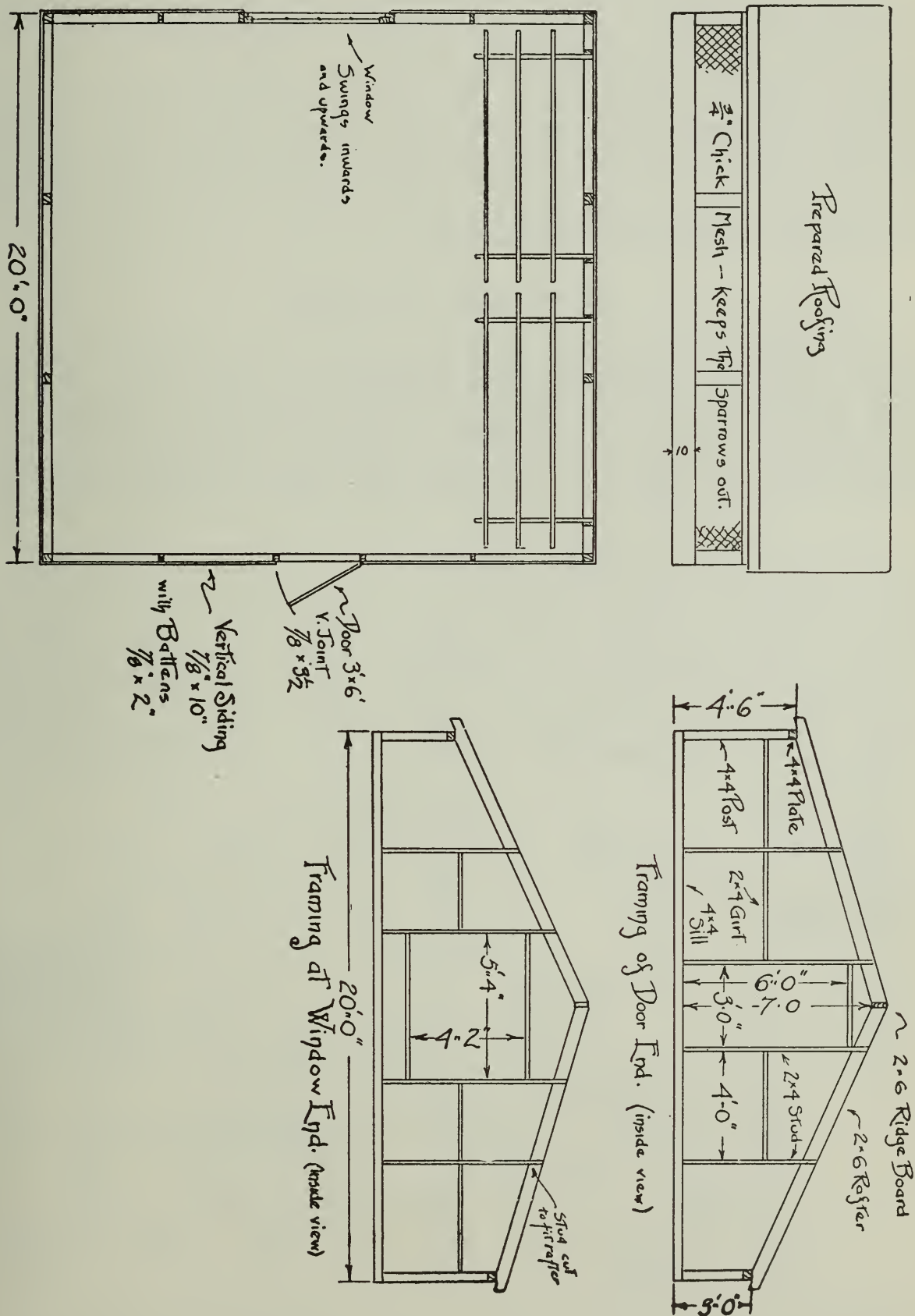


Fig. 57. Plan elevation and framing sections of a twenty-foot square Open Front House, suitable for the accommodation of one hundred hens.

enough back to be out of the draught. When a smaller house than one twenty feet square is desired it may, for example, be built twenty feet deep and ten feet wide, rather than ten feet deep and twenty feet wide. The width across the front should never exceed the depth in this type of house.

Snow will occasionally blow into the house but we have had very little trouble in this respect. Having the building deep, low and narrow tends to prevent this. A rather small opening in front will not allow the wind and snow to blow far back into the house and the depth allows the birds to keep out of the wind. If there is continuous rainy or damp weather for several days the litter will become damp and should be removed at once. Both walls and floors must be kept dry or the birds are likely to suffer from disease of some kind. There should be no openings except those in the front, otherwise there is likely to be a draught through the house, and this should be avoided.

General Rules for Building

It is necessary to allow from four to six square feet of floor space per bird, the amount actually required depending upon the size of pen and type of construction. The larger and more open the pen, the less floor space is required per bird. Roosting requirements differ with the different breeds. Brahmas, Cochins and other heavy breeds require ten inches of perch room per bird; Plymouth Rocks, Wyandottes, Rhode

WALL NESTS.

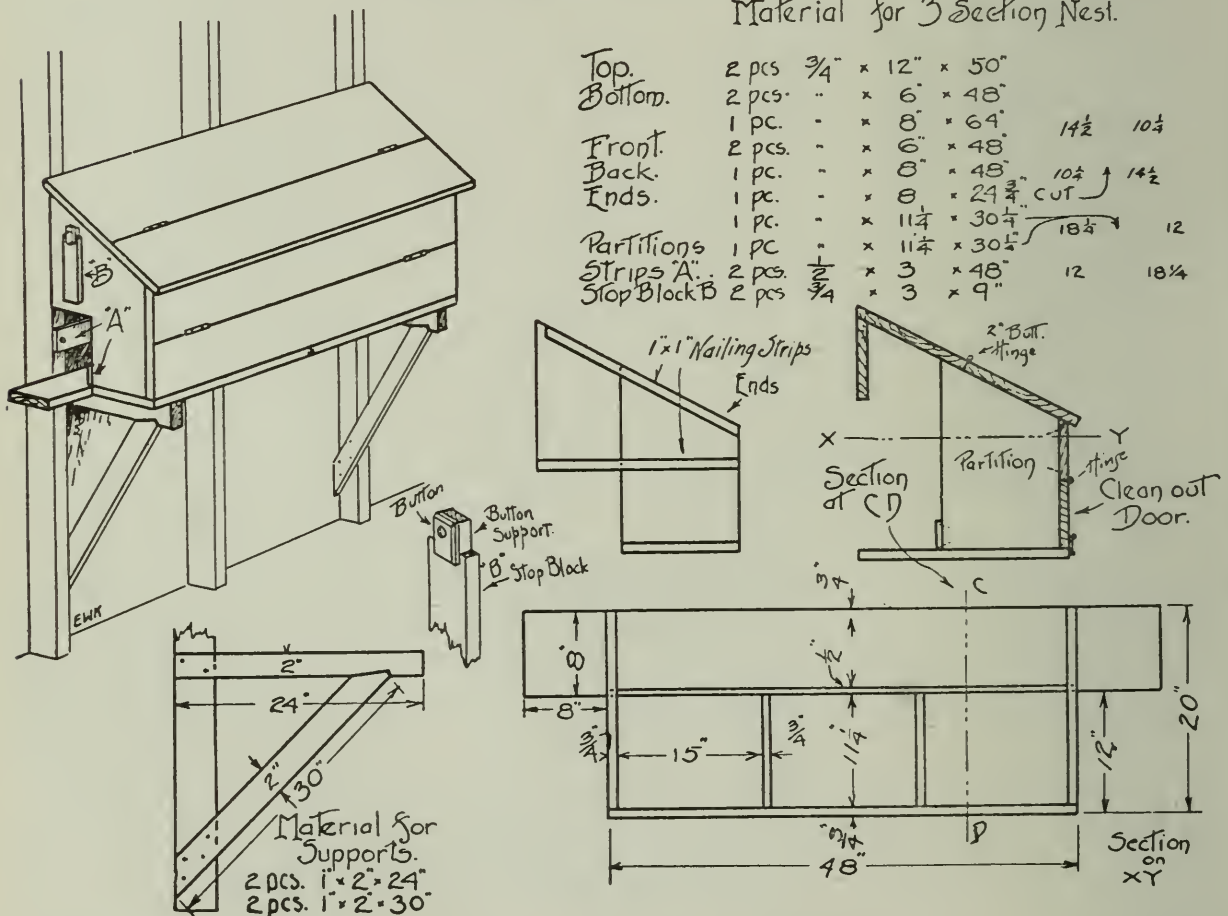


Fig. 58. A convenient type of open nest which may be supported upon brackets on the wall, allowing free use of floor space for the hens.

Island Reds, etc., require about nine inches; and Leghorns, etc., about eight inches. All perches should be placed on the level, as in Fig. 52. Perches built ladder style result in the birds crowding on the top perch, thereby causing trouble. Roosts should be built low or near the floor. There are several reasons for this. Birds of the heavy breeds cannot fly high up, and any bird is liable to injure the soles of its feet in jumping down from high perches.

When dropping boards are used they should be moderately low down to admit of easy cleaning. Dropping boards should be made of matched lumber and should be twenty inches wide for one roost and three feet wide for two, the first perch being placed ten inches from the wall and the others at fourteen inch centres.

Roosts two inches square or two inches by three inches, are preferred, the upper edges to be slightly rounded.

Nests should be provided at the rate of one nest to every four or five hens in the pen. All types and sizes of nests are used, but with open nests more trouble may be experienced with hens eating their eggs. This is overcome by providing nests which are partially darkened, as in the case of Fig. 58. The semi-darkened nest may also assist in preventing vent picking and cannibalism. Raising nests off the floor permits the use of the entire floor space for scratching purposes. All nests should be from twelve to fourteen inches square and not over six inches deep.

Trap nests are necessary where pedigree breeding is to be conducted. Whether it is advisable for a man to trap-nest his stock will depend upon his object, the time available, and the expense he is willing to incur in attaining the same. The price of trap-nests varies from eighty cents to one dollar and eighty cents each. The cost of operating the same is approximately one dollar per bird per year, which will not include the keeping of progeny test records. Where trap-nests are used they must be visited at one and one-half hour to two hour intervals during the day.

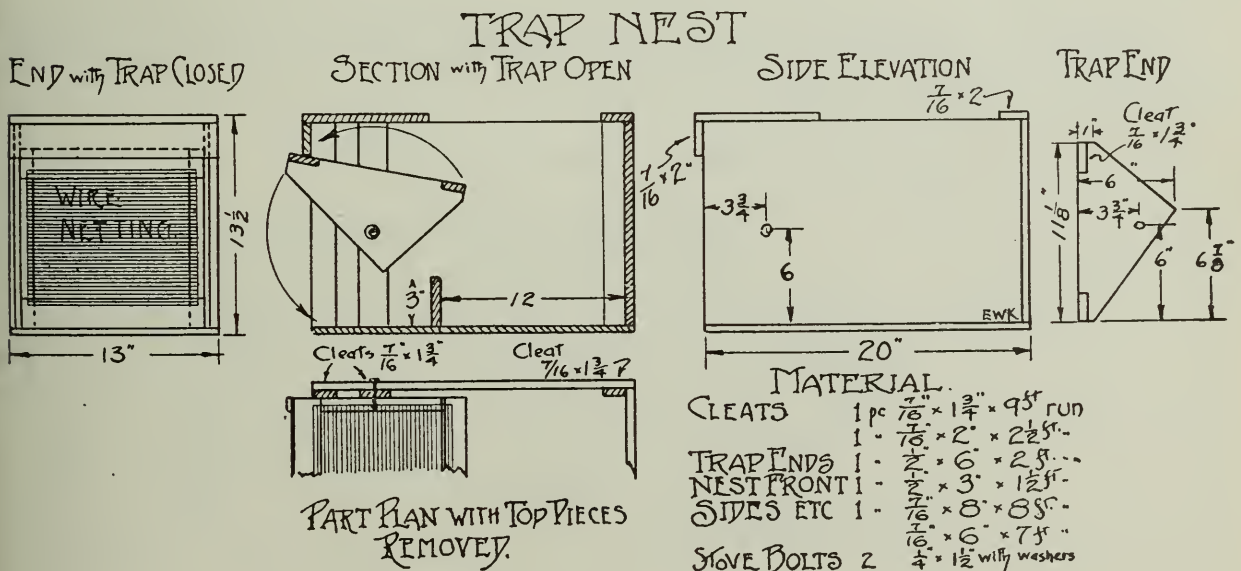


Fig. 59. Plan and specifications for the trap nest in which the type of construction of trap and its adjustment allows for the entire lower section of the front to be open. This greatly facilitates removing the hens from the nest.

This is especially important during hot Summer weather, as otherwise birds are liable to die on the nests from suffocation.

Trap-nests are for the most part patented. The nest which we have used for a number of years, and which we believe is as efficient as any on the market, is the one shown in Fig. 59. This nest represents in a general way the type of most trap-nests. It is made up of two compartments, with a trap or door on the front end which closes automatically upon the bird's entrance into the nest, thus keeping the bird captive until released by the attendant.

The nest is constructed of seven-sixteenth inch material, twenty inches long, thirteen inches wide and thirteen and one-half inches high. The front of the nest is left open at the bottom which greatly facilitates the removal of the hen after laying. A three inch board is placed across the bottom of the nest and divides it into two compartments. The trap has a straight wire front and is so adjusted in the nest that as the bird steps over the three inch partition her back comes in contact with the trap and it tips forward, thereby closing the nest.

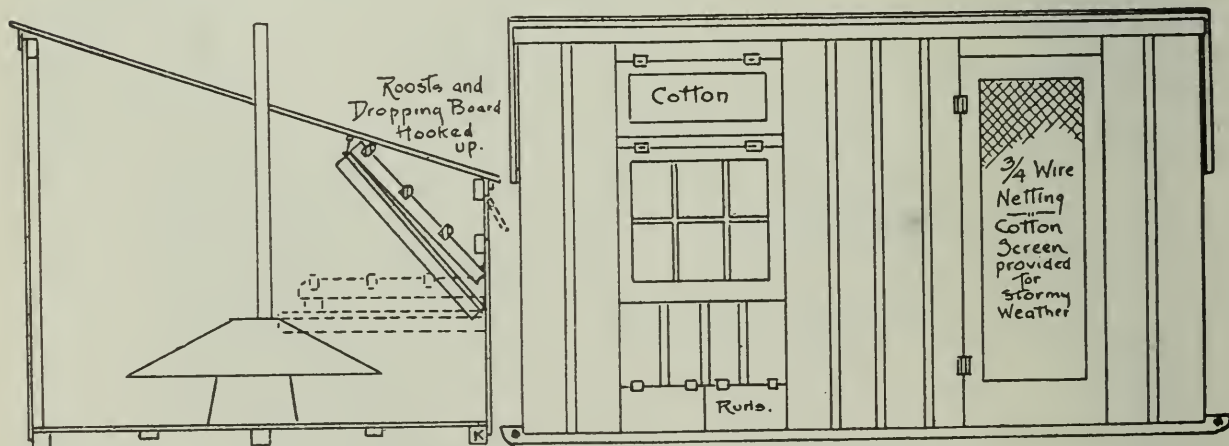
Drinking utensils of some form or other are necessary and the more simple they are in construction, the better. The writers have found open pans as efficient as any, the size of the pan depending on the size of the flock to be accommodated. They should be made of some material which is smooth and as free from seams as possible, to facilitate cleaning, because frequent cleaning of drinking utensils is necessary to prevent them from becoming slimy and unsanitary. In large flocks we have used steel hog troughs, holding from twenty to thirty quarts, with good results.

In our experience the largest egg yields are obtained from flocks containing twenty to thirty birds. Some succeed with two hundred or more in a flock. Considering, however, the cost of housing, labour, etc., the most economical returns will probably be secured from flocks of about one hundred birds.

Colony Houses

There is a constant demand from people living in towns and cities for plans of houses suitable for housing six to twelve hens. In some in-

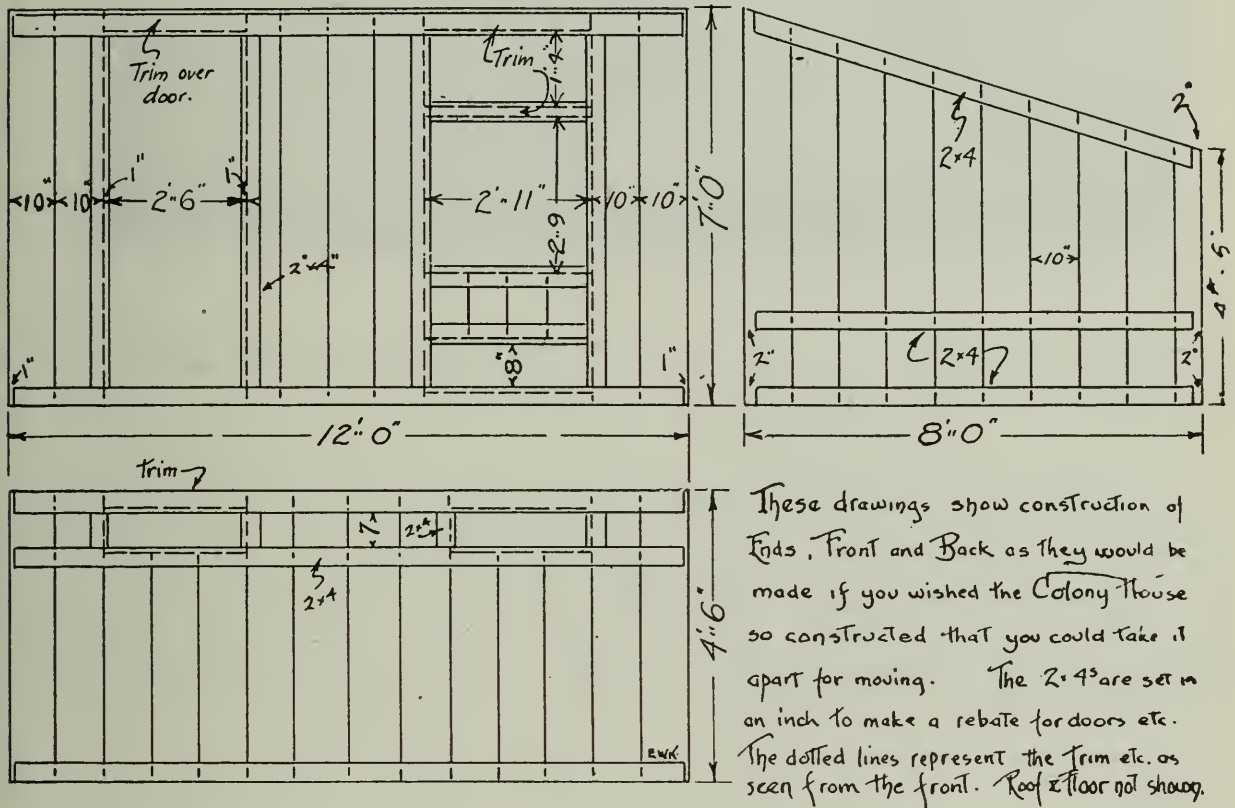
COLONY HOUSE or BROODER HOUSE.



Elevation and Cross Section of a Colony House 8' x 12' Suitable for Coal Burning Brooder Stove.

stances they wish these houses so constructed that they can be moved easily from place to place.

The man who is using artificial means of brooding and raises over one hundred chicks, is finding the portable colony house a valuable addition to his equipment, as it enables him to place his young chicks on fresh ground every year.



These drawings show construction of Ends, Front and Back as they would be made if you wished the Colony House so constructed that you could take it apart for moving. The 2x4s are set in an inch to make a rebate for doors etc. The dotted lines represent the trim etc. as seen from the front. Roof & floor not shown.

Fig. 60. Plans showing front, end and rear wall construction where desired to have the house of the take-down type.

Bill of Material for 8' x 12' Colony House

- 3 pcs. 4"x 4" x 14' Hemlock, Cedar or Pine Runners
- 2 " 2" x 4" x 12' Hemlock or Spruce Runners
- 2 " 2" x 4" x 14' Hemlock or Spruce End Sills—Girts
- 7 " 2" x 4" x 16' Hemlock or Spruce Rafters
- 3 " 2" x 4" x 12' Hemlock or Spruce Plates, back girt
- 6 " 2" x 3" x 14' Hemlock or Spruce Corners, door and window sides
- 3 " 2" x 3" x 12' Spruce Roosts
- 100 board feet, face 7/8" Spruce flooring
(16' long) Floor
- 210 board feet, 1" x 10" Outside Sheeting
- 250 lineal fet, 1/2" x 2" Battens
- 110 board feet, roof boards—Hemlock
- 1 square shingles
- 3 pieces 1" x 4" x 14' Door and cornice
- 2 pieces 1" x 3" x 10' For cornice ends
- 1 sash, 1 3/8" thick; 6 lights, 10" x 14" glass.

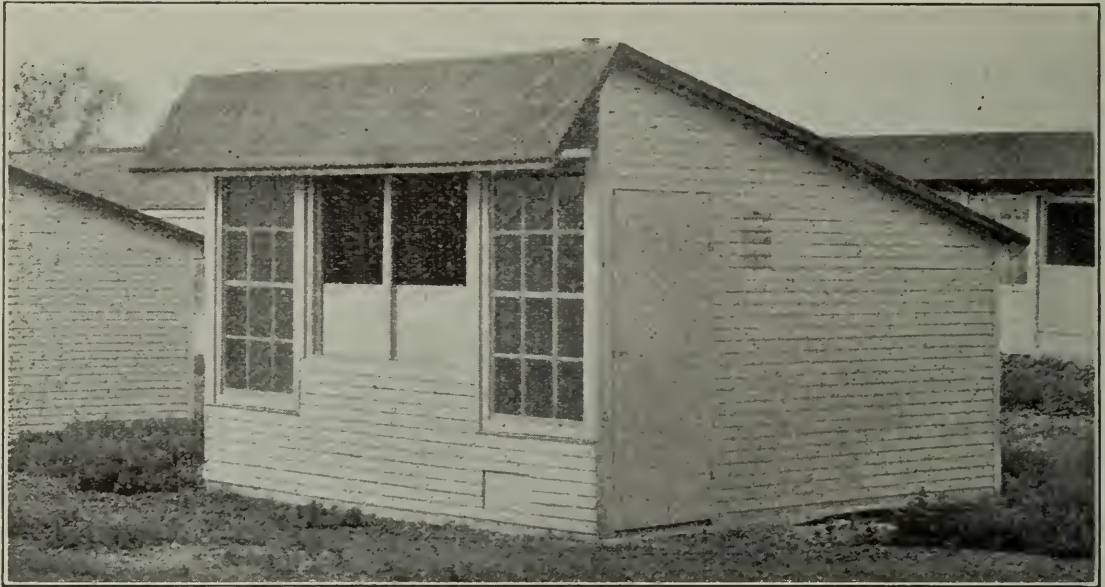


Fig. 61. Colony House 12' x 12' suitable for large size brooding pen or small mating of breeders.

In Figs. 61 and 62 are shown a large type of colony house which is suitable for operating a colony coal-burning brooder stove, rearing chickens on range, or for a small breeding pen. The house is twelve feet by twelve feet, built on runners and, while portable, cannot be moved as easily or satisfactorily as the smaller house. This house has been tested out by the writers, both for brooding and for wintering laying hens, and has proven quite satisfactory.

Bill of Material for 12' x 12' House

3 pieces, 4" x 4" x 14'	Runners
11 pieces, 2" x 4" x 12'	Hemlock Joist Plates
16 pieces, 2" x 4" x 14'	Hemlock Rafters, Studs, etc.
3 pieces, 2" x 2" x 12'	Roosts
200 feet Matched Hemlock Roof Boards	
230 feet 1" Spruce Flooring, 12' long, Floor and drop board	
300 feet 1" Novelty Siding, 12' long, outside walls	
8 pieces 1" x 3" x 14', for window casings and cornice	
10 pieces 1" x 2" x 14' for screens (cotton for winter)	
3 yards 30" wire for screens (wire for summer)	
4 yards 36" wire for windows	
100 feet ½" matched Spruce sheeting inside, above drop board	
2 Sash, 12 lights, 10" x 14", 1⅜" thick	
2 Square Paroid Roofing	
1 Door, 2' 7" x 5' 11" and join	
Dropping board is 3' 8" wide x 12' long	
3 Roosts 10" above drop board, 8' long, about 12" apart.	

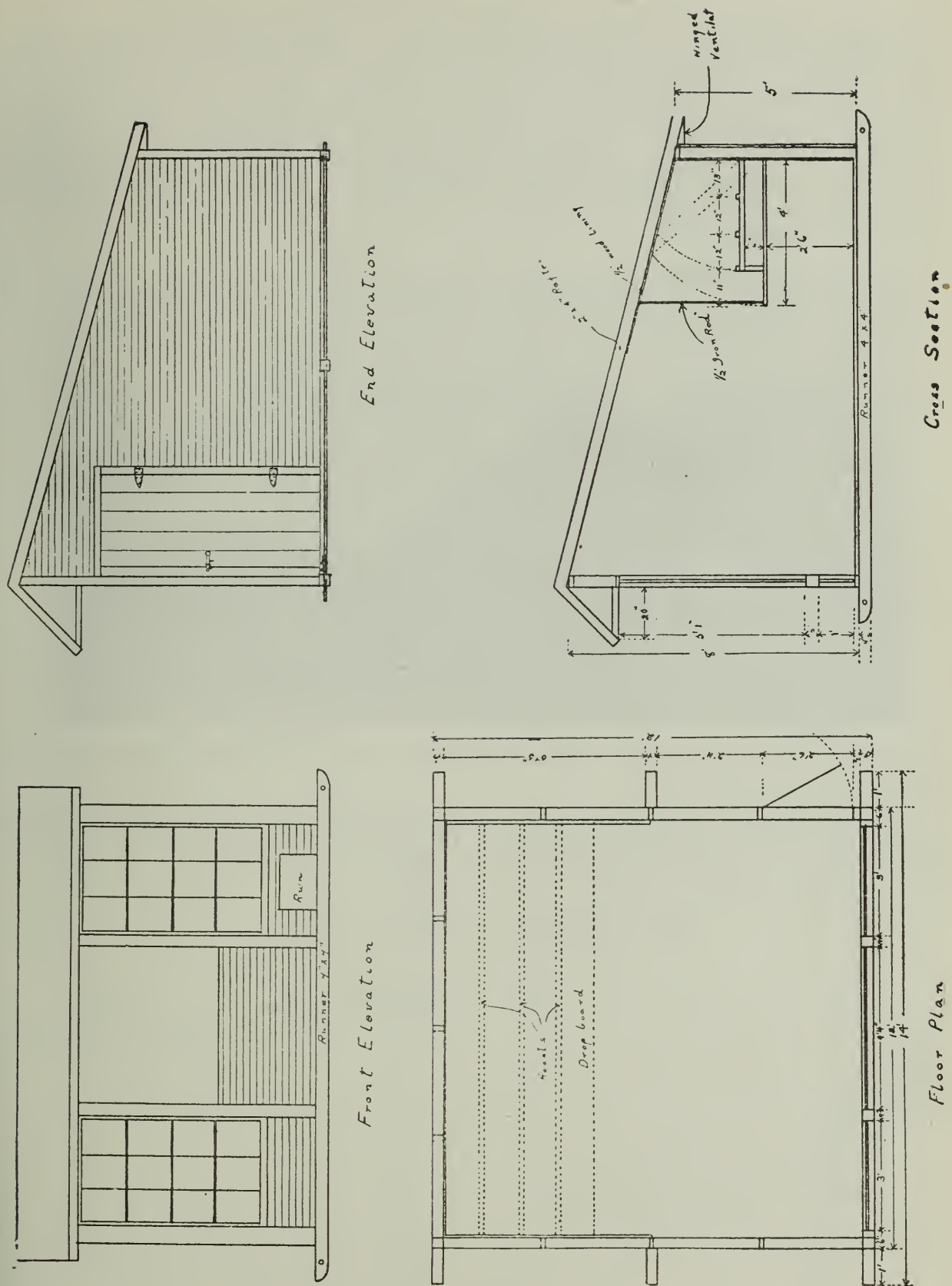


Fig. 62. Plans, elevations and cross-section of 12' x 12' Colony House, suitable for Colony Brooder or Laying Pen.

Range Shelters

The use of the Range Shelter is becoming quite general. While not adaptable for early Spring use, it is just as efficient and much less expen-

sive than a Colony House as a shelter under Summer Conditions. It can be easily constructed by practically anyone. The structure is light and can therefore be easily moved about the range. The usual practice is to place a shelter beside a colony house of chickens, and as they grow and the house becomes crowded, and when heat is not essential, the chickens overflow to the shelter. In late June or early July, chickens not requiring heat may be transferred directly to the shelters. Where the surroundings become badly soiled with droppings or mud, the shelter should be moved to a new location.



Fig. 63. Range Shelter for range rearing after chicks are feathered and are safe to leave without artificial heat.

Bill of Material and Plan for a Range Shelter as used at the Poultry Department are submitted herewith. There are other types in use but this one has proven satisfactory and inexpensive.

Bill of Material for Range Shelter

Parts	Number of Pieces	Size	Length
Roof	12	3' x 4'	Masonite Prestwood
Rafters	20	1" x 3"	6'
Ridges and Eaves	3	1" x 3"	11' 5"
Plates—Side	2	1" x 3"	8' 4½"
Back	1	1" x 3"	7'
Front	2	1" x 3"	2' 6"
Sills—Side	2	1" x 6"	8' 4½"
End	2	1" x 6"	7'
Studs—Corners	4	2" x 3"	2' 8½"
Side	2	2" x 3"	2' 6"
Door	4	2" x 3"	4' 2"
Roosts	4	2" x 2"	8' 5"
Roost Brackets	4	1" x 3"	2' 5"
Door—Stiles	2	1" x 3"	3' 5"
Rails	2	1" x 3"	2'
Wire	14 yards	24" wide	
Hinges	1 pair	3" Butts	
Hook and Eye	1 set		
Joist for Floor Screens	3,	7/8" x 4¾" x 6' 10¼".	

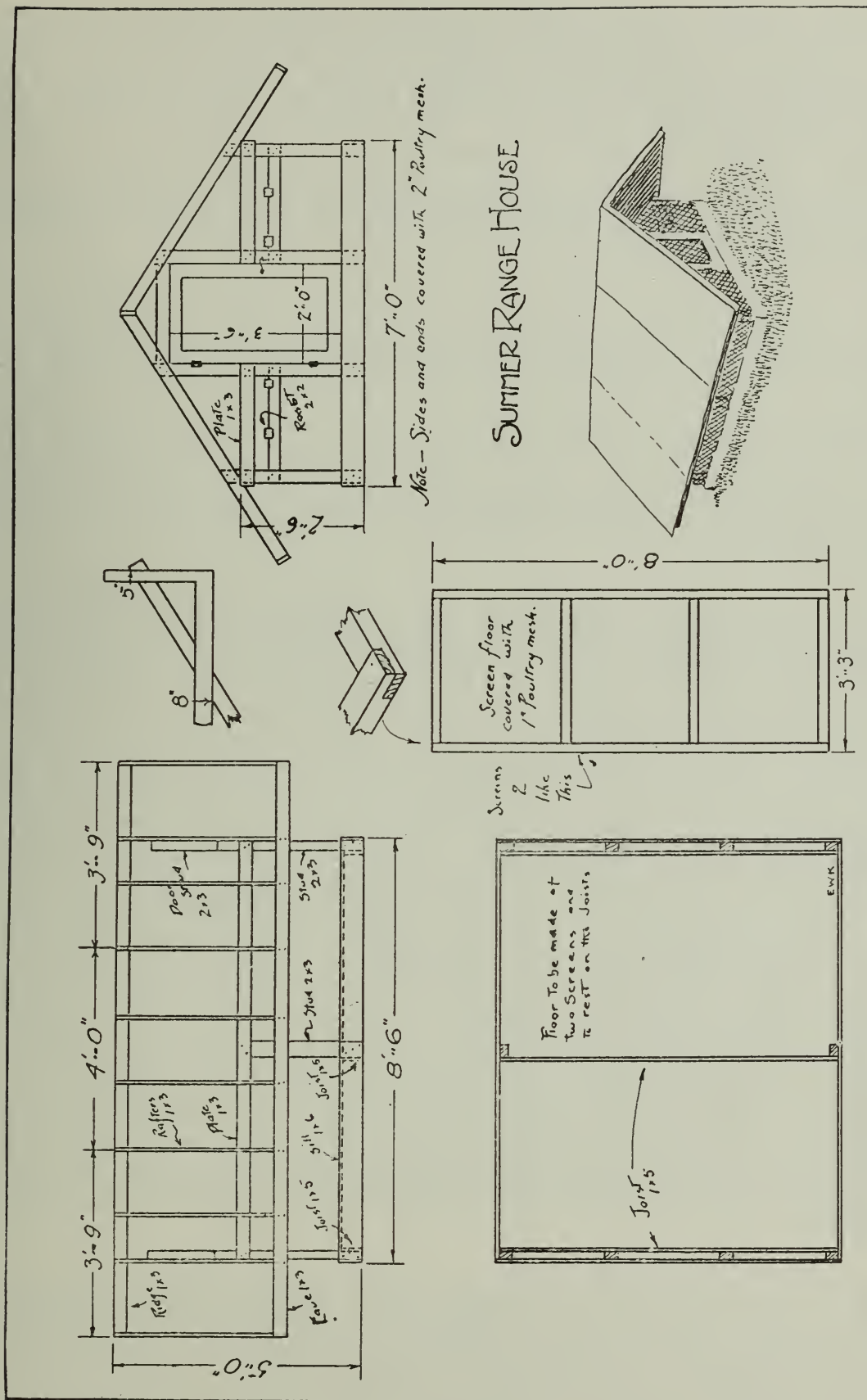


Fig. 64. Plans and construction detail for Range Shelter shown in Fig. 63.

POULTRY HYGIENE AND SANITATION

There is a very great doubt in the minds of the writers as to the advisability of "doctoring" sick chickens. The unit of production (the individual bird) is so small in value that if a man's time is worth anything it will not pay him to doctor a sick chick unless he considers the bird

especially valuable. The "cured" bird may always remain a menace to the flock, and upon the slightest adverse conditions may show a return of the disease. Disease of any kind usually weakens the constitution of the individual, and hence lowers its breeding value. In such simple diseases as indigestion, colds, etc., where the greater part of the flock is affected, and the flock can be treated as a unit, treatment is, no doubt, advisable. Where the birds are kept for the production of eggs and meat only, the hatchet will be found the safest and most effective method of treatment for individuals.

Prevention is better than cure, and every effort on the part of the poultry keeper should be exerted to maintain such environmental and sanitary conditions as will prevent disease gaining a foothold in the flock.

The stock which is used for breeding purposes should be selected first for constitutional vigour, as this is the foundation upon which the breeder must build future success. Discard all birds that have at any time been sick, and cull very closely birds which, as chicks, were raised in closely confined quarters.

The housing of the birds is very important in the prevention of disease. Abundance of fresh air and sunshine in the house, without draughts or dampness, will do much in maintaining a healthy flock. Houses must be kept sanitary by the frequent removal of droppings, also the litter as it becomes soiled. At least once during the year, preferably about the month of August, the house should be thoroughly cleaned and disinfected. All movable fittings such as nests, hoppers and roosts, should be removed from the pen to facilitate cleaning. Thoroughly scrape the dropping boards, if used; remove all litter from the floor and then brush the ceiling and walls with a broom. Scrub the pen thoroughly with soap and water, or a lye solution, UNTIL IT IS CLEAN. The house is now ready to be disinfected. The writers find it advisable to apply a coat of whitewash to all pens once a year to brighten and help to cleanse them. They have also found it most economical to combine the whitewashing and disinfecting processes by adding the disinfectant to the whitewash. The whitewash is made according to one of the formulae given below. To this is added five per cent of crude carbolic acid or some of the tarry compounds used for disinfecting purposes, and the whole applied with a hand spray pump. A pump capable of developing a fair amount of pressure is desirable as it forces the solution into all the cracks and crevices about the building. Nests, roosts and other movable fittings are best treated by dipping them in disinfectant, or they may be sprayed, but dipping is preferred.

The land upon which birds are running must receive close attention in order to keep it clean and sanitary. The constant ranging of birds over a piece of land tends to foul it, making it "chicken-sick." The heavier the soil the more serious is the trouble. Aim to cultivate the run or yard at least once during the year and grow a crop of grain or rape on it. This tends to cleanse the soil of droppings and at the same time produces succulent green feed for the birds.

Follow a three or four year rotation for chicken range and move the range equipment three or four times each season. Avoid ranging young stock on land used for old birds, as such land may be badly contaminated with worms and coccidiosis.

The feed must be closely attended to and no feed given the birds that is musty or mouldy, or in which putrefaction has started. Only the purest and most wholesome feeds should be fed, or they will not only have an ill effect on the health of the birds, but seriously affect the product from the flock.

Exercise is very essential to health and this applies to chickens just as much as to other classes of stock. It is particularly important in the Winter months, especially if one wishes to secure good hatches of strong, vigorous chicks.

In case of sickness, isolate all such birds from the flock and either treat or destroy them. All dead birds should be disposed of by burying them deeply (two or three feet) or by burning them. The latter is the safer method of disposal.

Birds which are badly infested with vermin, such as lice or mites, will not thrive. If the vermin are not kept under control they will in time become so bad as to seriously lower the vitality of the birds, thus rendering them more susceptible to disease.

Quarantine, for two or three weeks, all stock being introduced into the flock from outside sources. This may avoid starting an epidemic and heavy mortality.

WHITEWASHES FOR FARM USE

E. W. Kendall, B.S.A., Department of Farm Mechanics

Whitewash has a wide application to farm use and deserves a much greater popularity than it, at present, enjoys. Its ingredients are inexpensive and readily obtained. It is not difficult to make and it is easy to apply. In addition to these advantages, it protects the surface to which it is applied, brightens up dark interiors and improves sanitation. A fact not generally known is that whitewash may be coloured, provided that light tints and shades are used and that the pigments are not affected by lime. Among such are yellow ochre, raw and burnt umber and raw and burnt sienna.

Preparation of the Surface. The surface to be whitewashed should be just as clean as one that is to be painted and it is a first essential to good results that all dirt, grease and scaly material be removed before there is any attempt to apply the wash. This implies a liberal use of scrapers and stiff brushes. When the cleaning is finished and the surface dusted, it is well to dampen it slightly before applying the wash.

Application of Whitewash. Whitewash may be applied with a brush or with a sprayer. In applying with a brush use one at least four inches wide and work rapidly, making no attempt to "brush out," as in painting. Let the coat be fairly thin and transparent. It will be opaque when

dry. Small hand sprayers such as sold by Seed Firms may be used. These will cost around \$10.00 and should be of brass if you expect them to last for a number of years. In using sprayers it is quite necessary that the wash be strained through at least two thicknesses of cheese cloth. Spraying under certain conditions has many advantages over brushing, as it forces the material into cracks and crevices that would not be reached by the brush. In using the sprayer always hold the nozzle so that the wash is applied at right angles to the surface; this gives even application. The sprayer should be thoroughly cleaned after use and especially the nozzles, as a small particle of dirt clogging one side of the nozzle will cause it to send out a lop-sided stream, and the work will be patchy.



ONTARIO DEPARTMENT OF AGRICULTURE

PARASITES INJURIOUS TO SWINE

Lionel Stevenson, Provincial Zoologist.



ROUND WORMS

'Twenty-four Round Worms taken from the intestine of a three-months-old pig.

This very common parasite causes the loss of many thousands of dollars each year. Probably ten per cent of all pigs born die, due to its presence, and a handicap is placed on all pigs during the first four months of life. As a pig grows older the injury lessens. Protect the young from the ravages of this worm.

THE SWINE PARASITE HANDICAP

Much of the unthrift seen in young pigs is due to parasitism. The young in particular suffer from the various parasitic invasions, old animals generally develop an immunity against intestinal parasites and show little or no evil from the presence of a few worms. The older or breeding animals of the herd will, if not treated with an efficient vermifuge and handled under highly sanitary conditions, harbour enough worms to keep the premises seeded down with worm eggs, a very undesirable condition when we consider the safety of the young pigs born on such premises. The little



A colony house located on clean, fresh ground makes an ideal home for the young pigs. It is during the period of babyhood that the damage is greatest from worm infestation. Give the young pigs a colony house located in a corner of the clover field in which to start life.

pig born of a parasite infested mother, living in a pen or yard where worm eggs make up a good percentage of the dust or filth on the pen floor, has not a chance in the world of escaping infestation. The first time the young pig seeks nourishment while nosing around the teats of his mother, he will get a mouthful of worm eggs, in this way starting the parasitic handicap the day he is born.

THE WORMY PIG AS A COMMERCIAL PROSPECT

With high-priced feed, building equipment and labour to be balanced against the sale price of the product, the part that we call labour income, or profit in our pig feeding activities, may be adversely affected by the presence of parasites. Too frequently the parasites take all of what might have been profit and the labour has been in vain. The profitable pig is the disease free pig that reaches the approved bacon weight when it is six months old. The pig that takes eight to twelve months to reach bacon weight is not profitable frequently for the reason that it has carried the worm handicap, under which it was a waster of grain and labor. A pig infested with internal parasites can not be profitable, as it is robbed of food, irritated and poisoned.

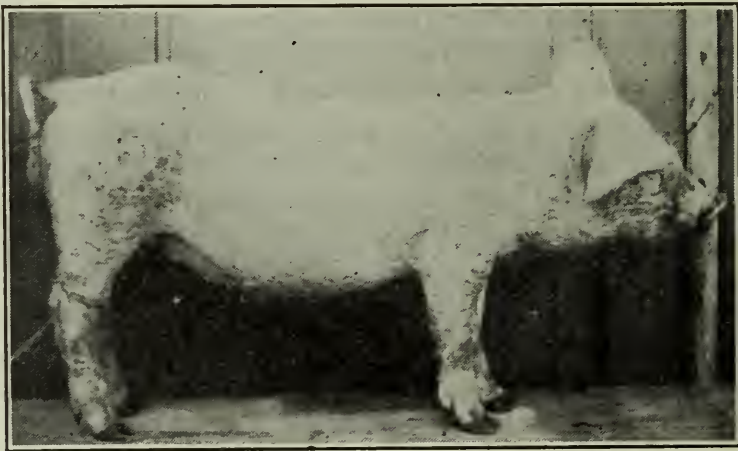
The Round Worm of Swine (*Ascaris lumbricoides*)

Description—The colour varies from a greyish yellow to a light pink in adults. The young ascarids are white or cream coloured. In size, the adult females vary from eight to fifteen inches in length, while the males are smaller and do not often exceed nine inches in length. Ascarids of all sizes ranging from a fraction of an inch up to 18 inches in length may be found in the same pig's intestine. Large specimens have a mid-body diameter of one-third of an inch or less and taper toward the extremities. The tail end or posterior extremity is bluntly pointed, while the head end of the ascarid terminates in a mouth, consisting of three lips, the margins of which are dentate. The dorsal lip is furnished with two sensory papillae each with a double termination. The two ventral lips each carry one large double papilla

and two small ones. The males are easily distinguished from the females in that the posterior end is bent, and the body of smaller diameter than it is in female of equal length. The females have a straight posterior end, as shown in the illustration representing the Round Worm of Swine. The vulva of the female is located in a band-like depression at a point, when measured from the head, at about one-third the body length toward the posterior end. The egg of the female ascarid is ovoid in form, a small percentage will show some variation from the ovoid form and may appear to be elongated or to be nearly round in outline. Eggs are produced in great numbers, one female ascarid may during a full life time release 25,000,000 or more eggs. The eggs are well protected by an albuminous coat and can stand much adverse weather to which they may be subjected to after passing from the body of the pig with the feces.

Life History—The eggs of the ascarid must pass from the body of the pig in order to reach conditions of temperature, moisture and oxygen supply suitable for the hatching process. The normal temperature within the intestine of the pig is such that it retards the development of the worm egg, so a very large percentage pass out with the pig feces in the same stage of development acquired at the time the egg left the uterus of the female worm. After passing from the body with the pig feces, the eggs will, if conditions are very favourable, develop to the vermiform stage in from ten to fourteen days. Should the temperature and moisture conditions not be favourable the eggs may be destroyed or their development be retarded. It is generally retardation, as the eggs are hard to destroy. The ascarid egg is very resistant to weather conditions and is not injured by the severe winter weather in Ontario, if given the protection of ordinary pig yard filth. The moisture factor required for the incubation of the ascarid egg is never wanting on the floor of the average pig pen, so this factor is generally favourable in the winter and frequently so in the summer in many indoor shelters or pens. The temperatures of piggeries vary greatly during the year, ranging from 40 degrees to 80 degrees F., the higher temperature being favourable to the incubation of the eggs, while the lower temperature is not favourable. In temperatures below 70 degrees F., development is slow and it may take weeks for the eggs to become vermiform. Fertilized eggs may remain on the pen floors, in wallow holes, manure piles, or surface soil of yards for a year or more, to become vermiform when exposed to conditions of light, heat and moisture suitable for the incubation process. The embryonated or vermiform egg is taken by the little pig while nosing around the breast of the sow, or while taking feed from the pen floor or feed trough. Should the pen be inhabited by a wormy brood sow (we find that 50 per cent of the brood sows carry worms), the floor of the pen will be heavily seeded with worm eggs, so there is, under such conditions, no escape for the young pigs. They will be wormy, too. After the vermiform egg reaches the small intestine of the young pig along with the food swallowed, the shell of the egg is dissolved off and the young worm is released. Once free in the intestine, it penetrates the wall to reach a blood vessel. It is very small and very active at this time, being but from .2 to .3 millimeters long (that is, 125 of these larval worms, placed head and tail would measure approximately one inch). Once in a blood vessel the little worm is carried to the liver, then to the heart and from there to the lungs of the host pig. The conditions existing in the lung, suit the larval development of the worm and

it remains there for a period of six or eight days, growing in that time to about 2.4 millimeters in length. This developmental stage being completed the little worm leaves the lung tissue and passes by way of the bronchi and trachea to the throat to be coughed out or swallowed. If swallowed, it returns to the intestine of the pig, where it may lodge and grow to sexual maturity in eight to ten weeks' time. If coughed out into a feed trough it may be taken up by another pig. Many of the young worms apparently do not find conditions just right in the intestine of some pig and fail to gain lodgement; however, enough worms find congenial conditions to cause them to grow to maturity and keep the plague going. This peculiar round or cycle, vermiform egg to the stomach, the larvae from the stomach to the intestine, then into the blood stream to the liver, heart and lungs, and then back to the intestine may cause considerable damage to the lymph glands, liver and lung tissue of young pigs. Any degree of injury may follow the migration of the ascarid larvae, depending upon the numbers migrating and the susceptibility of the pig. Heavy infestations complicated by the presence of pathogenic bacteria bring on the condition known as ascaris pneumonia, often fatal to the young pig. With moderate infestations no marked symptoms are present, the young pig gradually descends into the class of the unthrifty and fails to develop at a satisfactory rate.



PIG INFESTED WITH ROUND WORMS

I am lop-eared and pot-bellied. Nobody loves me. The worms think I am useful as a home and the Boss thinks he owns me. The worms are certainly putting one over on the Boss. If I ever get up to bacon weight, it will be during my old age.

Symptoms of Infestation—During the initial stage, with a heavy migration of larvae in progress, the temperature may go up to 105 degrees F., or even higher—the respirations become more frequent and may be irregular in character—a husky cough is generally present. As the pig grows older, if the infestation is heavy it becomes unthrifty, pot bellied, poor doer, with a variable appetite. Some days pigs do not feed well, other days they can not get enough. Diarrhoea alternates with constipation in cases where the infestation is heavy. When the infestation is light, no symptoms indicating the presence of worms may be noted. A post mortem examination may or may not reveal the presence of Round Worm in the intestine, but certain definite changes are noted in the lungs and liver, coming from the migrating young worms.

Distribution—The *Ascaris lumbricoides* is found wherever pigs are reared. Very few herds are entirely free from the pest. Pigs that are raised under strict hygienic conditions are much less infested than those reared on farms where no attention is paid to the hygiene of the farm yard.

Control and Prevention—One wormy pig will seed down with worm eggs every foot of pen floor space, of yard space and pasture area over which it may roam. One female Round Worm in the intestine of a pig will each day pass out approximately 20,000 eggs. Ten female worms would be good for a production of over a million a week. The fertility percentage of the ascarid eggs is very high, and given suitable conditions nearly all will become vermiform, that is capable of infesting any pig that might take them up. This rapid reproduction suggests a line of action in control—stop worm egg production by destroying the worms in the intestine of the pig. Begin with the brood sows. The sow should be given a suitable vermifuge at a time not later than two weeks before she is due to farrow. Various substances can be used as Tetrachlorethylene, the Nema Capsule, Santonin, Arecanut, or Oil of Chenopodium. Two days after dosing the sow should be washed with soap and water, in order that her skin and hair be free of worm eggs. With worm egg production stopped, and the sow's body clean, she should be moved to a pen that has been specially prepared for her to farrow in. The point to keep in mind in preparing a farrowing pen is to remove or destroy all the worm eggs that are on the floor of the pen. This is best done by scraping and then scrubbing with hot water and lye (30 gallons of hot water to 1 pound of lye). With worm egg production stopped, the sow's body surface free of eggs and a clean pen for the young pigs to be born in, the litter will have a good chance to be free of Round Worm infestation, and if further protected until they are four months old they will be able to make normal gains. Protection for the young pigs is best given by rearing them on land on which swine have not been for at least two years, or keeping them in pens that have been specially scalded out until such time as they have acquired a fair degree of immunity (usually when four months old). If pigs are to be moved from the pen that is worm egg free to a clean pasture, care should be exercised to see that contamination is not picked up on the way, by allowing the sow or the pigs to walk through dirty yards, or pens. The moving is best done by loading the sow and the pigs into a suitable crate and hauling the same to the new location. Worm eggs stick, and a sow can carry enough on her feet to seed down the new location, so use the crate and stone-boat or wagon. Pigs that are reared free of Round Worms up to four months of age will not be seriously handicapped by later infestation. Old pig pens, old yards and wallows, the sanitation of which has been neglected for years are a menace to the well-being of the young pigs, in that such places harbor many millions of Round Worm eggs. Keep the young away from such places. Build colony houses and hurdles or portable fence, and set apart an acre or two of clover land on which to raise the young pigs. Remember that a young pig can pick up enough worm eggs in an hour around an old yard or pen, to fill him up with worms a few days later.

Administration of Vermifuges to Pigs—The pig has a peculiar, narrow throat, and care must be taken in dosing. Thin liquid medicines are always dangerous, as such are apt to enter the trachea (wind-pipe) and suffocate the pig. In giving free running liquids do so slowly and give the pig its own

time to swallow. Gelatine capsules containing drugs can be administered safely to pigs and with comparative ease. Thick viscous liquids like castor oil or molasses can be used as carriers of drugs with no risk to the pig.

Lung Worm of Swine (*Metastrongylus elongatus*)



Thread Lung Worms emerging from the bronchioles in a piece of lung cut from the posterior portion. These worms spend their entire adult life in the lung.

Description—A long threadlike smooth worm usually white in colour (sometimes stained brown), mouth small, lips two, each lip divided into three lobes, six papillae are present and surround the mouth orifice. The males are from one-half to one and a quarter inches long, while the females vary from one to two inches in length. The eggs are oval in outline and have a thick transparent shell, they vary from 60 to 100 microns long and from 40 to 60 microns wide. The egg contains a visible embryo when released by the female worm. The male worm is furnished with a two-winged bursa and two very long barbed spicula.

Life History—This lung worm has a simple life history and does not require an intermediate host for its larval development. Young pigs become infected very early in life if the brood sow is a carrier of lung worms. Mature lung worms have been taken from a pig but four weeks old, which would indicate that infective larvae had been taken up by the pig during the first few days following birth or that the infection had been parental. The infested brood sow will expel quantities of lung worm larvae and eggs from her body with the feces or by coughing. These discharges will in part reach the feed trough or the breasts of the sow, either before or after be-

coming vermiform (infective) and from either position the young pig will take up the infective lungworm larvae while seeking nourishment. Lung worm eggs and larvae in all stages of development will be taken up by the pigs in feeding, but only those that have advanced through a definite number of moults and survived become infective to the pig, a comparatively small number, but enough to keep the species going. On reaching the intestine of the pig with the inješta, the young worm will, if it succeeds in reaching the mucous membrane, burrow in and reach a blood vessel. Once in the blood stream it may be carried to any tissue in the body. In the lungs the larvae that are to survive escape from the blood capillaries and enter the alveoli, eventually moving out into the smaller bronchi where they continue growth and reach sexual maturity in two or three weeks time. Eggs containing well developed embryos are deposited by the worms in the bronchi, these or a large percentage of them will complete their hatching process and leave the lungs by way of the trachea to be coughed out or swallowed to pass out with the feces. A sojourn in the outside air is necessary for development to the infective stage, which involves two moults. The young larvae having completed its "outside life" can withstand adverse weather conditions for a long period (over a year) while waiting to be taken up by a pig.

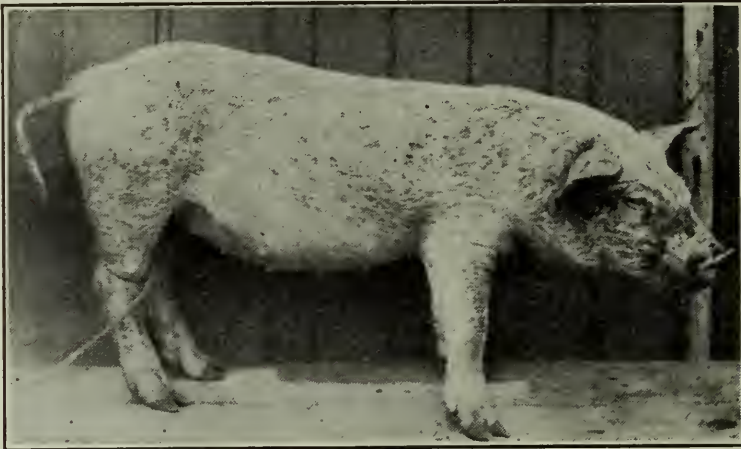
Symptoms of Infestation—A short husky cough, at long intervals after the pigs are roused from their beds or after exercise is usually indicative of Lung Worm. In severe infestations there may be paroxysms of coughing and the discharge of seromucoid secretions. If the infestation is light there are no noticeable symptoms, while a moderate infestation will bring all the evidences of general unthrift. Intense infestations with the usual bacterial complications may kill the pig in ten days or less.

Distribution—The Lung Worm is quite common in large herds, where many pigs are kept in the same pens or on the same ground year after year. Where but one or two brood sows are kept and these given considerable liberty as to range and living quarters little trouble is experienced with Lung Worm.

Prevention and Control—Keeping pigs away from their own body discharges or those of other pigs infested with Lung Worms is the policy of protection that should be adopted by all persons raising swine. The close confining of pigs in numbers in soiled pens and contaminated yards makes it impossible for the pigs to keep infection out of their bodies. A clean start in life, that is being born of a worm free mother, in a worm free pen and then required to live in a sanitary way, puts the young pig beyond the Lung Worm handicap. The breeder that has Lung Worm free breeding stock, and premises that have not been contaminated by lung wormy pigs for at least three years will have no trouble with Lung Worms providing that contamination is not carried in with purchased stock, or with sows brought in for breeding, or in filth carried on the boots of people moving from farm yard to farm yard. The breeder that purchases stock to strengthen his herd, neglecting the consideration of the possible introduction of Lung Worm infestation may bring trouble into his herd. A microscopical examination of the discharges from pigs will usually determine the presence or absence of worm infestation.

When once established in a herd of swine, Lung Worm can be combatted by keeping pigs on cement floors or by adopting the colony house with open range rearing. Floors and feed troughs should be scalded at least once in ten days, throughout the year. Drugs are of but little use in combatting Lung Worms. Sanitation at all times aided by the free use of scalding hot water on floors is better than drugs and disinfectants.

Mange



A victim of lice and mange mites. Pigs in constant misery from the irritation of external parasites cannot be profitable. Give the pigs a chance to keep free of external parasites by providing a Rubbing Post and a supply of crude oil.

Two varieties of Mange Mite attack swine in Ontario, the Sarcoptic mite and the Demodectic mite. The Demodectic form of mange in swine is not common, but the Sarcoptic form is very frequently seen. Male animals that are kept for service in a community, are often very badly crusted with mange, and serve as distributors of the pest. Herds are frequently seen in which every animal old and young is a victim of mange. The loss through the neglect of owners to take such measures as will protect their herds from this irritating pest, amounts to many thousands of dollars each year.

The Sarcoptic Mange mite can be seen with the unaided eye, as a very small moving grey speck in the scales scraped from an infested area. Pigs become infected about the eyes and base of the ears, and from this location the infection spreads backwards, and will, if not checked, cover the entire body with a hard shield like grey scaly mass. The scales form wherever the mite has been at work and result from its habit of penetrating into the skin with its stylet causing erythema, which is followed by the formation of vesicles and crusts. It is beneath the crusts that the Mange Mite is to be found.

Control and Prevention—Sarcoptic Mange can be successfully treated by the use of stock dips that are of a penetrating nature. Any of the following will, if properly applied, give satisfactory results:

(a) Sulphur	2 pounds
Oil of Tar	8 ounces
Raw Linseed Oil	1 gallon

The mixture is heated and applied quite warm. Pigs should be well washed with soap and water to remove as much of the scale as possible, when dry apply the mixture with a stiff brush, leave for ten days, then wash off, dry and repeat the treatment.

(b) Creosote 1 part
 Raw Linseed Oil 19 parts
 Wash the pig, dry, and apply with a brush.

(c) Creosote 1 part
 Lard 25 parts
 Wash the pig, dry, and apply with a brush.

(d) Lime and Sulphur Dip.
 Flowers of Sulphur 3 pounds
 Unslacked lime 1 pound
 Water 10 Imperial gallons.
 Submerge the pig, that the dip may reach every wrinkle about the face and head.

Pigs should be kept away from filthy wallow holes, and given clean dry quarters. Pens should be sprayed with a strong disinfectant at frequent and regular intervals. A Crude Oil Rubbing Post should be set in every pig yard or pen, that the pig can go and take a rub whenever it feels an itch.

Follicular Mange (*Demodex folliculorum suis*) Red Mange

The Demodetic or Red Mange is caused by a mite so small that it is not visible to the unaided eye. This mite burrows into the skin by way of a hair follicle. The skin becomes red, hairless, thick and crusted. The irritation set up in the inflamed area is most intense.

Control and Prevention—A high degree of sanitation about the premises and the immediate removal of all animals showing the presence of this form of mange. Treatment of individual cases is difficult as the young mites are out of reach of the ordinary dip remedies, and the time and attention required is too great to expend on an animal of comparatively low value. The disposition of all infected animals by slaughter as soon as it is possible to market them is advised. Pens should be thoroughly cleaned and disinfected and not used for pigs for six weeks after being occupied by mangy swine.

Pediculosis

The common Hog Louse is responsible for a higher cost than need be, in the production of pork on many farms. The pig with a continual itch cannot be a profitable feeder and the general neglect on the part of swine feeders to subdue this active blood sucking pest is costing them a lot of money. One pair of lice let have their way for three months will fill a pigery with their progeny, very much to the discomfort of the pen imprisoned pigs. The lice being very active blood suckers, brings about a condition of puritis, causing the pig's skin to be covered with papules and scales. The infested pig will be restless, continually rubbing to get relief and will be unable to sleep either day or night. It is the pig's business to lie quiet and grow fat, but how can it do so if the owner allows lice to worry it day and night. The profit on a litter of hogs of fattening age may be entirely lost, or young pigs may die due to neglect to control lice. There is another reason why lice should not be tolerated, they are carriers of bacterial diseases.

The Hog Louse (*Haematopinus suis*)

Description—The Hog Louse is very large and active. The females are one-fifth of an inch long and measure about one-tenth of an inch across the widest part of the abdomen. The males are a little smaller than the females. The head is cone-shaped, very long and yellowish-grey in colour.

The thorax is brown in colour and broader than long. The abdomen is oval in outline and yellowish-grey in colour.

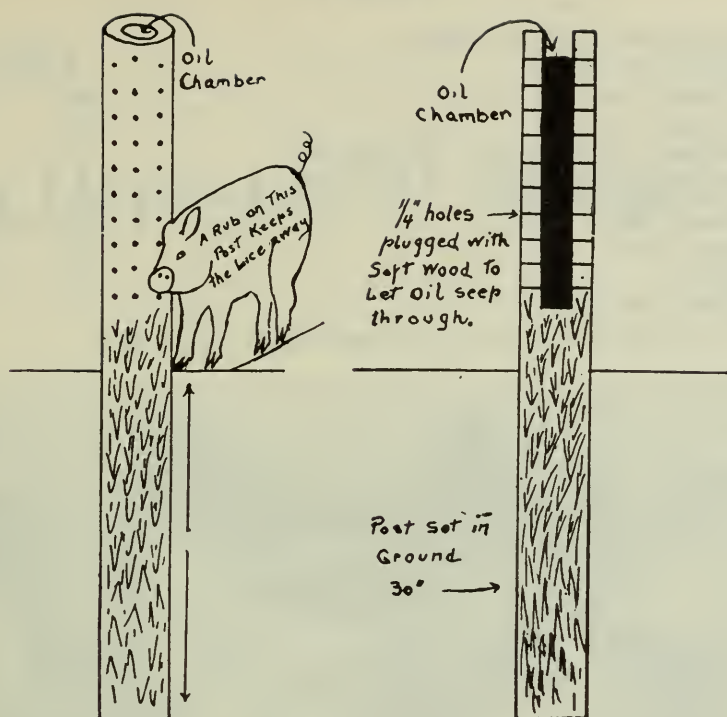


HOG LOUSE (*Haematopinus suis*), enlarged (x9)

These lice cause much discomfort to young pigs and are responsible for considerable loss. Lice are easily controlled by keeping the premises clean and using oils on the body of the pig. Crude oil is highly satisfactory and cheap. Give the pigs an oil post and let them rub.

Life History—These lice live on pigs both old and young, migrating from animal to animal when opportunity offers or spending a lifetime on one individual. The sexes mate on reaching sexual maturity, and the female louse soon starts egg laying. The fertilized eggs are produced at the rate of eight to twelve a day, and each egg is glued to a hair near the skin. The eggs hatch in ten or twelve days' time if the pig is housed under conditions favourable to the breeding of lice. Many eggs are produced by each female, and if but fifty per cent. hatched and matured, the offspring in four generations would be over half a million lice, from one pair in three months' time. On emerging from the egg the young louse which is a miniature of the parent, seeks a thin skinned area where it may enter its proboscis and obtain blood. The young louse goes through three moults, taking in all about three weeks to reach sexual maturity.

Prevention and Control—Measures to remove lice from the herd should embrace activities directed in the following lines: (1) the destruction of the lice present on the pigs; (2) destroying the eggs; (3) preventing reinfestation by cleaning up the pens and keeping infested pigs away from the premises. The Hog Louse is easily destroyed and the pig will do most of the work connected therewith if a suitable oiler is provided. Oilers may be home-made or purchased contrivances to serve the purpose of supplying a limited quantity of crude oil to the skin of any pig that has the desire to rub. Crude oil may be applied with a brush or swab, it is cheap and highly efficient. Kerosene Emulsion can be used against the Hog Louse and if applied as a dip is very effective. It is made as follows:—dissolve 8 ounces of laundry soap in one gallon of boiling water, then add two gallons of kerosene (coal oil), mix well while hot. This is the stock solution. For use add nine gallons of soft water to each gallon of stock solution. Kerosene Emulsion is best used in the dipping tank; however a fair application can be made to the pig's body through the use of a spray pump or sprinkler can. Oily solutions should be applied in the evening or the pigs kept in the shade



Oil Post made by boring a two inch or three inch hole in one end of a post, to serve as an oil chamber. This oil chamber is tapped by boring a series of quarter inch holes from the outside into it and plugging these small holes with soft wood, to allow the oil to seep through. Just enough to deliver a little oil to the pig's skin.

and not exposed to the bright sun. Blistering results if a freshly oiled skin is exposed during the heat of the day. Stock dips made from coal tar preparations as creolin, lysol or kresol can be used in the dipping tank with excellent results, as such not only destroys the lice but cleans the lesions, reduces the irritation and promotes healing. Whatever treatment is applied it should be repeated in eight or ten days to destroy any lice hatching since the first application was made. After dipping or spraying the pigs put them on clean ground and give them a louse free shelter. Clean up the old pens and yards, soak the floors and walls with a strong disinfectant to destroy the lice that are always present in such places if recently occupied by lousy pigs. A three weeks' rest for a pen or yard will give the lice time to die.

Vermifuges Suitable for Swine

Tetrachlorethylene.

Administered in capsule after starving the pig for 18 hours.

The dose of Tetrachlorethylene is as follows:—

For pigs up to 50 pounds in weight use	1 CC
" " " " " " " " " " " "	2 "
" " " " " " " " " " " "	5 "
" " " " " " " " " " " "	10 "

Areca Nut (Fresh pulverized).

Administered in a handful of feed after starving the pig for 24 hours.

The dose of Areca Nut is, one grain for each pound weight of pig. That is a pig weighing 100 pounds would take 100 grains of Areca Nut.

Oil of Chenopodium (Wormseed).

Administered with Castor Oil after starving pig for 24 hours.

The dose of oil of Chenopodium is one fluid dram to a pig weighing 100 pounds, given with two ounces of Castor Oil. Reduce the dose for smaller pigs and increase for larger ones.

Mineral Mixture, for use in Self Feeder.

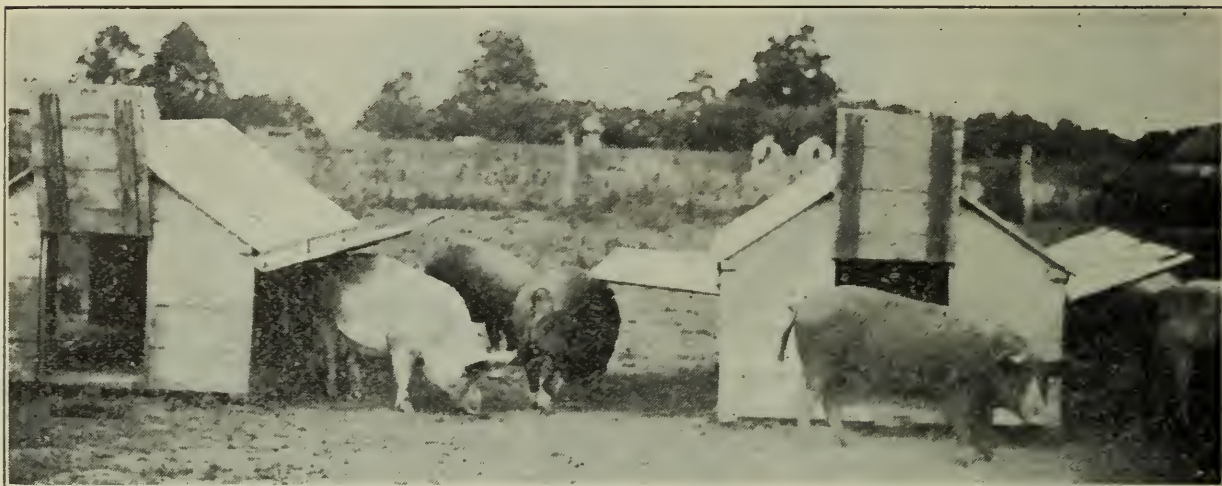
Sulphate of Iron	5	parts by measure
Hardwood ash	20	" "
Charcoal	75	" "

Place in a box and let pigs help themselves.

Mineral Mixture, for use with feed.

Steamed Bone Flour	50	pounds
Iodized Salt	10	"
Sulphur	2	"
Sulphate of Iron	2	"

Mix and use two pounds to each 100 pounds of grain fed.



The Colony House is easily moved to fresh ground and green crop forage. A dry location and sunlight are two very important factors in swine hygiene. The colony house excels in these factors so important to the vigor and thrift of both young and mature breeding animals. The colony house is moved to fresh ground so often as need be, and the pigs thereby removed from the location contaminated by their fecal matter which may contain many worm eggs.



Young pigs reared away from the old pens and old buildings have a much better opportunity to escape the worm handicap than those pigs that spend their early life around such places. Green feed, sunshine and pure air play a part for which there is no substitute in rearing pigs.

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BULLETIN NO. 381

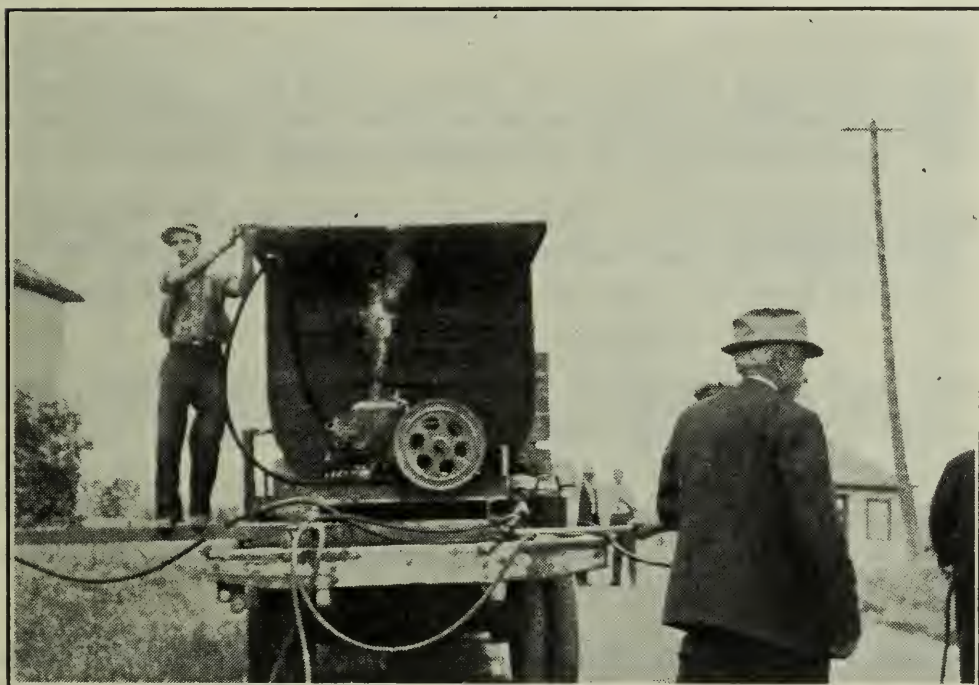
NOVEMBER, 1936

Ontario Department of Agriculture

Weed Eradication By Chemicals

By W. J. STEPHEN, B.A., B.S.A.

Crops, Seeds and Weeds Branch



*Power sprayer purchased by Chinguacousy Township during 1936
for spraying weeds on township roads.*

INTRODUCTION

The recommendations contained in this bulletin, on the use of chemicals for the eradication of weeds and brush, are based on experiments which were carried out in 1935 at a number of points in Ontario to ascertain most suitable chemicals, proper dosages and other particulars incidental to obtaining the best results. Observations were made during 1935 and again during the late summer and early fall of 1936.

SODIUM CHLORATE

Sodium chlorate was found to be the most economical and effective chemical to use in the eradication of weeds and brush. If applied as outlined in this bulletin satisfactory results will be obtained at a cost that is not prohibitive.

WARNING TO THOSE USING SODIUM CHLORATE AS A WEED KILLER

(a) When spraying do not walk through the area sprayed. Spraying can be done by walking backwards or from the side. Try to keep the chemical off boots and clothing. Do not be careless.

(b) When spraying it is best to use rubber boots. Should sodium chlorate accidentally get on overalls and other clothing, wash it off before it dries. Serious fires and loss of life have resulted from carelessness in this regard.

(c) Pails and other utensils used should be thoroughly washed to remove the last trace of chemical before setting them away.

(d) Trucks, wagons and other conveyances used at time of spraying should be washed off two or three times a day, and if the weather is very hot and dry throw a pail or two of water on the bottom and sides of the box or platform every hour. Keep everything moist.

(e) Do not smoke when handling chlorates. Never strike matches on clothing worn at time of spraying.

(f) Be watchful, clean and use good judgment in the handling of sodium chlorate.

(g) Warn the public as to the danger of walking through areas that have become parched and dry from the use of sodium chlorate. Put up signs "Keep Off". After two or three good rains most of the fire hazard will have been removed.

HOW TO REDUCE THE FIRE HAZARD OF SODIUM CHLORATE

When the weather is dry and hot, mix calcium chloride with sodium chlorate for areas to be sprayed, through which the public is apt to walk, such as on roads, around buildings, in cemeteries, school yards, etc. One pound of calcium chloride in two pounds of sodium chlorate, or if the weather is unusually hot and dry and the humidity very low, three pounds of calcium chloride to five pounds of sodium chlorate will produce a mixture that is fairly free from fire hazard.

For further particulars see bulletin by Dr. W. H. Cook of the National Research Council of Canada on "Fire Hazards in the use of Oxidizing Agents".

ATLACIDE

Atlacide is reasonably safe to use as far as fire hazard is concerned. People who have spraying to do around buildings, on walks, etc., would be advised to use this material in preference to sodium chlorate and calcium chloride.

Operators who prefer to use Atlacide should remember that they must use approximately twice the quantity per gallon of water recommended for pure sodium chlorate to get satisfactory results.

PLANT CHARACTERISTICS

To obtain satisfactory and most economical results one must know a few general characteristics of the plant or plants to be sprayed, such as the type of root, date of maturity, whether they are annuals, winter annuals, biennials or perennials.

A fibrous rooted annual, for instance, requires less chemical to kill it than does a perennial with a deep tap root or underground root stock.

Knowing their date of maturity gives the operator some idea when to start spraying in order to complete the job before the plants go to seed.

AREAS TO BE SPRAYED

Areas to be sprayed for weeds should not be disturbed before spraying. Do not cut, plow or cultivate the fall before or during the year spraying is to be done, otherwise maximum growth and foliage may not exist. This is essential.

AREAS SPRAYED

Areas that have been sprayed should be left undisturbed until the following year. Do not cut, rake, burn, pasture, plow or cultivate until May or June of the next year. This is important.

AUTUMN SPRAYING OF WEEDS SUCH AS BINDWEED AND THE SPURGES

Areas that have been plowed or cultivated the fall previous or during the spring and summer the year spraying is to be done, should not be treated until October. This gives the rootstocks that have been broken

up and buried deeply a chance to send up branches and leaves. Touch up the following year if necessary.

TOUCH UP

After spraying, touch up or spray any plants that appear when well developed, and preferably just as they are coming into blossom. With a little perseverance a 100% kill can usually be effected in every case in one year.

WINTER ANNUALS

Do not allow winter annuals to go into the winter or seed may be produced when we least suspect it.

AMOUNT OF CHEMICAL TO USE PER GIVEN AREA

The following is only a guide as to the quantity of chemical to purchase with which to spray a given area:

(a) 1 pound of sodium chlorate may spray from 200 to 1200 square feet of annuals, biennials and certain perennials such as Chicory, depending on their density of growth and the particular weed to be sprayed. For instance, we found that $\frac{1}{4}$ pound of sodium chlorate per gallon of water will kill Wild Carrot or Chicory.

(b) $1\frac{1}{2}$ pounds of sodium chlorate will usually be sufficient for from 100 to 200 square feet of Field Bindweed, Leafy Spurge and Cypress Spurge.

(c) 1 pound of sodium chlorate for from 100 to 200 square feet will be found sufficient for weeds such as Poison Ivy and Bladder Campion.

SATURATE

Many an operator has failed to kill weeds by spraying because insufficient liquid was put on the leaves or branches. Spray to saturate to the ground or until the leaves start to drip. It is better to use less chemical per gallon and more water if necessary to get over a given area, but be sure to saturate.

BRUSH

Be sure to spray to saturation and soak the crowns well. This is essential.

WHEN NOT TO SPRAY

(a) Chemical Weed Killers should be considered as supplementary to good field husbandry practices. Use them as a last resort. Cultivate where possible and when advisable from the standpoint of economy. The extra amount of cultivation necessary to eradicate weeds on tillable land places the soil in better physical condition and should make it more productive.

(b) In flower gardens.

(c) Near hedges and ornamental shrubs and trees.

(d) Near vegetables and small fruits.

SPRAYERS

There are three main types of sprayers generally in use for spraying weeds with chemical weed killers, viz—

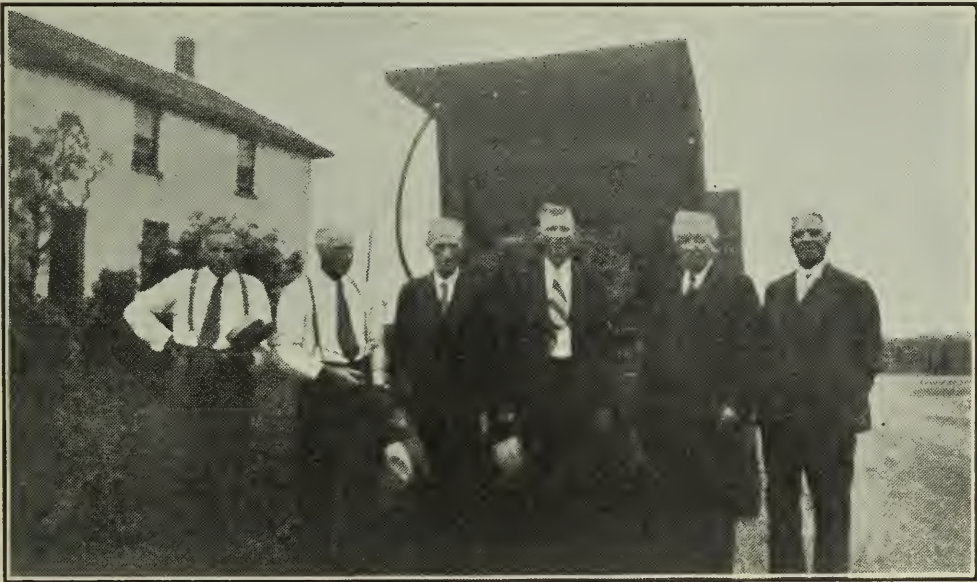
- (a) Knapsack. (b) Barrel. (c) Power.

Knapsack sprayers can be recommended for spraying small patches of weeds around buildings, on private roads, etc. They usually hold from 3 to 5 gallons. The pressure can be kept fairly constant at from 50 to 75 pounds. For large areas or for dense heavy growth of weeds they are not satisfactory. They do slow work and the pressure is not great enough to always effect a complete saturation of all plants to the ground.

Barrel sprayers do faster work and develop greater pressure than the Knapsack. From 100 to 250 pounds can be obtained.

Power sprayers are the most satisfactory. They are recommended for spraying large areas such as roadsides and for dense heavy growths of weeds and brush. They develop a pressure from 350 to 500 pounds which assures a complete saturation of all growth sprayed.

A number of Councils in Ontario have purchased power machines for roadside work.



Chinguacousy Township Council.

SPRAYING WEEDS AND BRUSH ON ROADSIDES

The time-honoured custom of mowing and cutting weeds on roadsides and digging out brush is fast going into discard.

The Department recommends that Councils with badly infested roadsides purchase a power sprayer and use sodium chlorate. Such sprayers should be equipped with at least two lines of hose and a 3 or 4 nozzle broom on each. A carriage can be extended out from the sprayer on which the operators ride. This idea was worked out this year by Mr. Fraser

Smith, Road Superintendent of Chinguacousy Township in Peel County, and is a very excellent one. It eliminates walking and the operators can keep dry and clean while the machine moves along at 1½ to 2 miles per hour.

COST

Spraying of weeds can be done the first year at the same cost or even less than that required for cutting and mowing.

RESULTS

In 2 or 3 years the roadsides will be clean. After the first year, each succeeding operation will be a "touch up" that is quite inexpensive.



Spraying weeds on roadsides in Chinguacousy Township with Township sprayer.

SPRAY CHART
ANNUALS AND WINTER ANNUALS

Name of Weed	Botanical Name	Chemical Recom- mended	Strength of Chemical	Application
Wild Mustard	Brassica Arvensis L.	Cyanamid	Dust	Dust 100 lbs. per acre of cereals and peas when the crop is 2 to 4 inches high. Dust when dew is on in the morning or after a rain. This is essential.
Wild Mustard	Brassica Arvensis L.	Blue Stone	Dissolve 20 lbs. in 100 gallons of water	Spray 100 gallons of solution per acre when the grain crop is 18" high.

ANNUALS AND WINTER ANNUALS—(Continued)

<i>Name of Weed</i>	<i>Botanical Name</i>	<i>Chemical Recom- mended</i>	<i>Strength of Chemical</i>	<i>Application</i>
Rough Cinquefoil	Potentilla Mons peliensis L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when in blossom. Repeat on stray plants.
Ragweed	Ambrosia artemisiifolia L.	Sodium Chlorate	Dissolve ½ lb. in 1 gal. water	Spray to saturation end of July. Repeat on seed- lings end of August.
Prickly Lettuce	Lactuca Scariola L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when plants are coming into blossom.
May Weed	Anthemis Cotula L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when plants are in blossom.
Lambs Quarters	Chenopodium Album L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when plants are in blossom.
Red Root	Lithospermum arvense	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation be- fore any seed is formed.

GENERAL REMARKS

Annual and winter annuals are shallow rooted plants usually with a heavy growth of leaves. They produce many seeds which ripen well before autumn. Generally speaking, these plants are not hard to kill. Spraying with a solution consisting of ½ to ¾ lb. sodium chlorate to one gallon of water before any seed is formed and preferably when in the blossom stage will usually effect a 100% kill.

BIENNIALS

<i>Name of Weed</i>	<i>Botanical Name</i>	<i>Chemical Recom- mended</i>	<i>Strength of Chemical</i>	<i>Application</i>
Burdock	Arctium Minus (Benk)	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray entire plant to sat- uration any time up to bloom.
Hounds Tongue	Cynoglossum officinale L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation where in blossom.
Sweet Clover	Melilotus alba & Melilotus officianalis L.	Sodium Chlorate	Dissolve ½ lb. in 1 gal. water	Spray to saturation when plant is well developed and before setting seed.
Blue Weed	Echium vulgare L.	Sodium Chlorate	Dissolve ½ to ¾ lb. in 1 gal. water	Spray to saturation when in blossom.
Wild Lettuce	Lactuca Canadensis L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when first bloom appears.
Wild Carrot	Daucus Carota L.	Sodium Chlorate	Dissolve ¼ to ½ lb. in 1 gal. water	Spray to saturation when in blossom.
Bull Thistle	Cirsium lanceol- atum L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when in bloom.

GENERAL REMARKS

Biennials are usually deeper rooted than annuals and theoretically should be harder to kill. This, however, is seldom the case. Wild Carrot, for instance, is one of the easiest weeds to kill. A 23% solution of sodium chlorate in water has in every case killed this weed when sprayed to saturation.

PERENNIALS

<i>Name of Weed</i>	<i>Botanical Name</i>	<i>Chemical Recom- mended</i>	<i>Strength of Chemical</i>	<i>Application</i>
Field Bindweed	<i>Convolvulus arvensis</i> L.	Sodium Chlorate	Dissolve 1½ lb. in 1 gal. water	(a) When Bindweed is growing in sod, spray to saturation when in bloom. (b) When Bindweed is growing on land that has been fall plowed, spring plowed or cultivated dur- ing the growing season, delay spraying until about October 1st. Repeat where necessary.
Chicory	<i>Cichorium Intybus</i> L.	Sodium Chlorate	Dissolve ½ lb. in 1 gal. water	Spray to saturation when in blossom.
Perennial Sow Thistle	<i>Sonchus arvensis</i>	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when Sow Thistle is about to bloom.
Curled Dock	<i>Rumex Crispus</i> L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when green and before it starts to change its colour.
Cyprus Spurge	<i>Tithymalus Cyparissias</i> L.	Sodium Chlorate	Dissolve 1½ lb. in 1 gal. water	Spray to saturation when in full bloom. Do this preferably not later than the first of August. Re- peat when necessary.
Leafy Spurge	<i>Tithymalus Esula</i> L.	Sodium Chlorate	Dissolve 1½ lb. in 1 gal. water	Spray to saturation when in full bloom. Do this preferably not later than the first of August. Re- peat when necessary.
Ox-eye Daisy	<i>Chrysanthemum Leucanthemum</i> L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when coming into bloom.
Canada Thistle	<i>Cirsium arvense</i> L.	Sodium Chlorate	Dissolve ¾ to 1 lb. in 1 gal. water	Spray to saturation when coming into bloom.
Upright Cinquefoil	<i>Potentilla recta</i> L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when in bloom.

PERENNIALS—(Continued)

<i>Name of Weed</i>	<i>Botanical Name</i>	<i>Chemical Recom- mended</i>	<i>Strength of Chemical</i>	<i>Application</i>
Poison Ivy	Rhus Toxi- codendron L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation any time during the growing season and preferably after July.
Arkansas Bed Straw	Galium arkan- sanum A. Gray	Sodium Chlorate	Dissolve 1¼ lb. in 1 gal. water	Spray to saturation when in blossom.
St. Johns Wort	Hypericum per- foratum L.	Sodium Chlorate	Dissolve 1¼ lb. in 1 gal. water	Spray to saturation when in blossom.
Bladder Campion	Silene latifolia (Mill)	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when in blossom.
Western Bull Thistle	Cirsium Undulatum L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when in blossom.
Catnip	Napeta cataria L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when in blossom.
Yarrow	Achillea Mille- folium L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when in blossom.
Tansy	Tanacetum vulgare L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when in blossom.
Golden Rod	Solidago graminifolia L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when in blossom.
Quack Grass	Agropyron repens L.	Sodium Chlorate	Dissolve 1½ lb. in 1 gal. water	Spray to saturation when Quack is coming into head.
Milkweed	Asclepias syriaca L.	Sodium Chlorate	Dissolve ¾ to 1 lb. in 1 gal. water	Spray to saturation when in blossom.
Orange Hawkweed	Hieracium aurantiacum L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation when in blossom.
Mullein	Verbascum Thapsus	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when full grown.
Plantain	Plantago major L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation when plant is well above the ground.
Dandelion	Taraxacum officianale, Weber	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray to saturation any time before plant pro- duces blossom.
Fall Dandelion	Leontodon autumnalis L.	Sodium Chlorate	Dissolve ¾ lb. in 1 gal. water	Spray to saturation be- fore plant produces blos- som.

PERENNIALS— (Continued)

BRUSH

<i>Name of Weed</i>	<i>Botanical Name</i>	<i>Chemical Recom- mended</i>	<i>Strength of Chemical</i>	<i>Application</i>
Willows	Salix L.	Sodium Chlorate	Dissolve 1¼ lb. in 1 gal. water	Spray until the leaves drip and saturate the crowns well. This is essential.
Dogwood	Cornus L.	Sodium Chlorate	Dissolve 1½ lb. in 1 gal. water	Spray until the leaves drip and saturate the crowns well. This is essential.
Choke Cherry	Prunus Virginiana	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray until the leaves drip and saturate the crowns well. This is essential.
Lilacs	Syringa L.	Sodium Chlorate	Dissolve 1¼ lb. in 1 gal. water	Spray until the leaves drip and saturate the crowns well. This is essential.
Wild Raspberry	Rubus L.	Sodium Chlorate	Dissolve 1 lb. in 1 gal. water	Spray until the leaves drip and saturate the crowns well. This is essential.
Maple	Aceraceae L.	Sodium Chlorate	Dissolve 1½ lb. in 1 gal. water	Spray until the leaves drip and saturate the crowns well. This is essential.
Wild Plum	Prunus Spinosa L. and Prunus Munsoniana L.	Sodium Chlorate	Dissolve 1½ lb. in 1 gal. water	Spray until the leaves drip and saturate the crowns well. This is essential.

GENERAL REMARKS

Perennials are divided into two main classes, viz. (a) Those with tap roots. (b) Those with trailing underground rootstocks. The former are much easier than the latter to kill and require a less concentrated solution.

ONTARIO DEPARTMENT OF AGRICULTURE
ONTARIO VETERINARY COLLEGE

MASTITIS OR GARGET IN COWS

by

C. D. MCGILVRAY, M.D.V., D.V.Sc.

FOREWORD

This bulletin has been prepared to meet a popular demand and to furnish such information regarding "Mastitis or Garget in Cows" as may seem justified at the present time. In the hope that it may serve a useful purpose it has been deemed desirable in its preparation to avoid the use of technical terms as far as possible. It should, however, be kept in mind that mastitis is essentially a serious infectious udder disease of cows requiring technical skill for its prevention and treatment. As a rule owners will find it both prudent and timely to consult their veterinary surgeon as to the handling of this disease as soon as it appears in their herds. By so doing those concerned will be serving their own interests rather than to attempt temporizing treatment of individual cases which may result in the further spread of the disease in their herd.

"The disease is not one which usually responds to ordinary palliative treatment but is one which requires skillful help and guidance for its control in most cases."

NATURE OF THE DISEASE

Mastitis, which is commonly known as "garget" is essentially a progressive inflammation of the milk secreting tissues of the mammary gland or udder.

High producing cows are to some extent most susceptible, hence the disease is more prevalent and detrimental in good dairy herds. It may occur in various forms influenced to some extent by the age and condition of the cow, high protein feeding, the degree and stage of lactation, the physical condition of the udder and the exact nature of the agent or cause responsible for the attack. For convenience of general description the various forms of mastitis may be divided into acute and chronic cases.

The initial attack may be acute and develop suddenly but generally speaking the majority of cases incline to the chronic form consisting of a progressive inflammation with occasional acute attacks.

The persistence of the inflammation damages and destroys the milk secreting tissues of the udder and results sooner or later in fibrous induration (caking or hardening of the udder) with altered and diminished milk secretion.

As a rule the disease is of infectious origin and is therefore frequently spoken of as "*Infectious Mastitis*" or "*Streptococcic Mastitis*". This is owing to the fact that the germs causing the disease usually belong to the streptococci group of bacteria. Mastitis has also a special significance in relation to public health as human beings may sometimes contract "septic sore throat" through the use of unpasteurized milk from affected cows.

CAUSE AND TRANSMISSION OF THE DISEASE

Acute Mastitis:

Acute cases of mastitis or garget may sometimes result from a variety of incidental causes such as bruises and injuries to the udder and teats;—over-feeding and over-stocking of the udder at calving time—allowing freshly calved cows with distended and congested udders to lie on damp, cold cement stable floors;—or to lie outdoors on cold, wet ground;—chilling of the udder through exposure;—irregular or incomplete milking. While these different causes may produce attacks of acute garget they are after all incidental and it should always be definitely understood that the majority of cases are caused by bacterial invasion or germ infection of the udder resulting in cases of infectious mastitis, which sooner or later incline to become chronic and persistent cases.

Chronic Mastitis

Chronic cases of mastitis are the most common and are invariably caused by bacterial invasion or germ infection of the udder. The disease germs belong usually to the streptococci group of bacteria of which the organism

known as the "*Streptococcus mastitidis (agalactiae)*" is the most frequent cause. Other bacteria:—"Staphylococci" also occasionally cause mastitis. Irrespective of the exact type of bacterial infection present, the disease is always of the same nature and readily conveyed from cow to cow in the herd, chiefly by the hands of the milker.

Affected cows always harbor the disease germs in their udders and the hands of the milker serve as the medium to carry and transmit the infection to the other cows during the ordinary process of milking. The disease germs gain entrance to the udder by passing up the teat canal. The milking of cows with soiled hands favors the spread of the disease from one cow to another.

What is known as "*wet milking*" (milking with wet hands) always aids in spreading the infection from one cow to another.

Milking by the use of a milking machine will also spread the infection unless the teat cups and other parts of the machine are kept absolutely clean.

The improper use of milking tubes and teat dilators may also be harmful

In any event the presence of a cow with infectious mastitis always results sooner or later in the widespread dissemination of udder trouble in a dairy herd.

As a rule the disease is first introduced by obtaining a cow with an infected udder and the prevalence of the disease in some herds is continued by the purchase of new additions to maintain the milking capacity of the herd. The spread of the disease is also favoured by unsanitary stable conditions and insufficient bedding in the stalls.

SYMPTOMS AND COURSE OF THE DISEASE

The symptoms and course of mastitis vary according to the cause as well as the nature and extent of the inflammatory process in the udder.

Acute Mastitis:

Acute attacks of garget are usually manifested by the sudden development of udder trouble and systemic disturbance. When acutely inflamed the udder and teats become hot and tender, highly reddened and tensely swollen. In severe cases the cow is feverish and the temperature rises, the appetite is lessened and rumination or "chewing the cud" ceases for a time.

The milk flow is immediately lessened and changed in appearance containing flakes and clots or it may be mixed with the inflammatory exudate consisting of a yellowish serous fluid or have a reddish bloody appearance.

Milking in these cases is difficult to perform as pressure on the teats increases the pain.

Where acute cases develop from incidental causes the course of the disease may be favourable and recovery may take place with proper treatment.

On the other hand, if septic infection is present pus may form resulting in abscesses developing in the udder, or the udder may become gangrenous (putrefactive) which is evidenced by the skin covering the udder and teats becoming a purplish or greenish-black color and the skin may slough or peel off in places. In such cases the udder may be permanently damaged resulting in the destruction of one or more quarters of the udder with "blindness" of one or more of the teats causing what are commonly known as "three teated cows." While acute attacks of garget are liable to occur occasionally in high producing cows during the first month after calving, nevertheless they may occur at other times during the course of infectious chronic mastitis. After all the chronic form of mastitis with or without acute attacks is the type of the disease which is most common.

Chronic Mastitis

Whenever udder trouble develops in a herd it should be suspected as infectious and chronic mastitis. The symptoms are not always definite at the beginning as little or no constitutional disturbance is present except when acute attacks occur sometimes.

In the chronic form of mastitis the inflammation is persistent and gradually progresses resulting sooner or later in diminished milk secretion. The milk is also altered in appearance becoming thinner and changed in color. It does not keep well and frequently contains flakes and clots which are characteristic.

For a time only one of the quarters may be affected but sooner or later the other quarters of the udder may also become involved. The inflammatory process tends to damage and destroy the milk secreting cells and tissues of the udder resulting in the formation of fibrous connective tissues (fibrosis) causing the affected parts to become firm and hardened (induration) and in some cases results in altering the general shape and appearance of the udder. Sometimes one of the first things to attract notice is the development of small firm lumps (nodules) in the udder near the base of the teats. The nodules or lumps gradually increase in size and numbers until they can be easily felt as distinct indurations or hardened masses. The normal healthy udder is always pliable and elastic to the touch after milking is completed and induration or hardening (fibrosis) of one or more quarters is indicative of mastitis.

In some cases abscesses develop in the udder and pus can be squeezed out of one or other of the teats. The ultimate effect of chronic mastitis is to damage the udder and where the damage is extensive one or more of the quarters may be permanently destroyed as far as milk secretion is concerned. The presence of chronic mastitis in a herd tends to spread from cow to cow chiefly by the hands of the milker resulting in a marked and serious loss in milk production.

THE DETECTION AND CONTROL OF MASTITIS

Every case of mastitis should be considered as an infectious udder disease which is liable to spread in a herd unless controlled.

The early detection and separation of affected cows forms the basis for controlling the disease. For detecting cases of chronic infectious mastitis the following diagnostic methods and tests are employed.

"Physical or Clinical Examination of the Udder": The attending veterinarian should make a careful clinical examination (palpation) of the udder of every cow on the premises.

The examination should be made immediately after the udder is milked empty and any cow showing the slightest sign of udder trouble (induration) should be removed from the regular milking line as well as those showing definite signs.

The affected cows should then be grouped together according to the stage and extent of the disease in their udders so that the slightly affected cows will be milked first and the worst cases last. The sound cows must always be milked first before commencing to milk the affected ones and the hands of the milker should be washed before milking each cow. This is important to prevent the further spread of infection from cow to cow by the hands of the milker. The clinical examination of the herd can be supplemented by the use of any of the other following methods of test or diagnostic aids.

"The Strip-cup Test": The strip-cup test consists essentially in the use of a porcelain or tin cup over the top of which is fitted a fine mesh screen or piece of black muslin cloth which serves as a sieve through which a little of the milk from each teat is squirted. Any clots or flakes present in the milk are caught in the meshes of the screen and can be readily observed. The presence of clots or flakes in freshly drawn milk is always an indication of garget and serves as a guide in detecting new cases.

"The Bromthymol Blue Test": This is known also as the thybromal test and is used to determine the alkalinity of the milk. The milk from mastitis cases is usually alkaline in reaction which this test will reveal. The test is of definite value when used by a skilled person together with a clinical examination of the udder of each cow and the use of the strip cup.

"Other Diagnostic Methods": There are a number of other reliable diagnostic methods used but they are of a technical nature requiring a knowledge of laboratory procedure and for that reason are not described in detail. They may be used when desired to make a more exacting examination of the milk and are termed respectively: The Chlorine Test; The Rennet Test; The Catalase Test; The Bacteriological Test.

PREVENTION AND TREATMENT OF MASTITIS OR GARGET

The prevention and treatment of mastitis or garget in any form is always troublesome. Acute and chronic cases should be regarded as being essentially stages or forms of the same disease.

Acute Mastitis:

In the prevention and treatment of cases of acute mastitis incidental causes should be avoided or corrected in the general management of the herd. Towards this end cows at the time of calving should be kept in clean, comfortable, well bedded stalls and protected against bruising of the udder; exposure and sudden chilling of the udder; over-feeding and over-stocking of the udder; incomplete and irregular milking. During acute attacks of garget the heat, pain and swelling (congestion) may be reduced first by the use of cold applications to relieve the congestion, followed by repeatedly bathing or fomenting the udder with hot water. This is best done following each milking and the milking should be done at frequent intervals preferably every two hours so as to keep the udder in a relaxed condition. This is essential in the treatment of all cases to relieve the tension on the inflamed glandular tissues. Bathing of the udder can be done to better advantage by means of canvas soaking bags or suspensory bandages applied by using pieces of felt or woollen blankets cut to fit the udder with holes for the teats and kept in place by fastening up over the back. Another means of applying heat is to coat the surface of the udder over thickly with hot antiphlogistine paste. Other popular applications are warm poultices and liniments. As a rule poultices are hard to keep in place and may fail in that respect to accomplish their purpose. Strong irritating liniments should be avoided but after the acute pain and heat is relieved the udder can be rubbed or massaged with a bland stimulating liniment or ointment such as iodine liniment or ointment.

At the beginning of an acute attack a dose of physic can be given consisting of a pound of Epsom salts dissolved in two quarts of water and given carefully as a drench. The diet of the cow must be regulated for a time and should consist chiefly of bran mash three times a day to which may be added a tablespoonful of hyposulphate of soda. In the medicinal treatment of individual cases the following drugs have been used quite extensively. Half an ounce of potassium nitrate (saltpetre) added to the drinking water once or twice a day as may be desired. Formalin and spirits of turpentine given in half ounce doses as a drench in a quart of milk two or three times a day. Vaccination has also been practiced but with doubtful results. Some also favor the drenching of the cow with a pint or two of its own milk from the affected quarters of the udder. Where abscess formation or gangrene of the udder develops special antiseptic and surgical treatment is necessary which should be done by the veterinarian in attendance. Generally speaking acute attacks of mastitis are benefited by the foregoing line of treatment if intelligently carried out.

Chronic Mastitis:

This form of mastitis or garget should always be regarded as a serious infectious udder disease which is liable to spread in a herd unless controlled. Unfortunately there is no specific vaccine or medicinal remedy available at the present time for the satisfactory prevention and cure of the disease. The control of infectious mastitis is based on the detection and separation of affected cows, and the building up of a sound herd as conditions permit. Whenever this udder disease appears in a herd the owner will be serving his own best interests by securing the services of a veterinarian for the purpose of detecting all of the affected cows and applying control measures and individual treatment as may be indicated. The first and essential thing to do is to have a careful clinical examination made by the attending veterinarian of the udder of every cow in the herd; supplemented by the use of the strip cup test and the bromthymol blue test or any other of the recognized methods of test. Following this every cow showing signs of udder trouble should be removed from the regular milking line. The cows should then be arranged in two groups comprising the group with sound udders and the group with affected udders. The group with sound udders must always be milked first and the milker's hands should be washed clean before milking each cow. This is important in order to prevent or limit the further spread of infection. The cows with affected udders should then be grouped separately according to the stage and extent of the disease in their udders. The milking of this group should be arranged so that the slightly affected cases will be milked first and the worst cases last. The affected cows should then be kept under observation and when considered desirable can be treated individually as already described, namely, by frequent milking to keep the udder relaxed; by hot fomentations or bathing the udder; by massaging or hand rubbing the udder with iodine liniment or ointment; by regulating the diet to lessen milk secretion, and by medicinal treatment. Cows with badly damaged udders should be removed from the herd—together with those which do not respond to treatment within a reasonable time. As in all other infectious diseases the aim should be to eliminate all of the affected cows that may act as carriers and spreaders of infection and to ultimately build up and develop a sound herd from the healthy cows and their offsprings. While this naturally will take time it should, however, be clearly understood that as yet no other satisfactory plan is available for controlling chronic mastitis in affected herds. The udders and flanks of all milking cows must be kept clean which can be done by regular brushing and washing from time to time. In milking affected cows care should be taken that none of the milk is spilled on the bedding. The stalls occupied by milking cows should be periodically disinfected and must be kept clean and well bedded. In the event of any new cows being purchased they should not be admitted to a clean herd until they have been clinically examined and tested and found to be free from mastitis. In order to protect public health the milk from mastitis affected herds should not be used for human consumption unless it is properly pasteurized.

ONTARIO DEPARTMENT OF AGRICULTURE

ONTARIO AGRICULTURAL COLLEGE

Peach Yellows and Little Peach

By L. Caesar and G. G. Dustan

INTRODUCTION

The two most serious diseases attacking peaches in Ontario are yellows and little peach. This is because trees once infected by either disease never recover and are worthless, and because if such trees are left in the orchard from one year to another, there is great danger of the disease spreading to the other trees and ultimately destroying the whole orchard.

How dangerous yellows and little peach can be may be illustrated by what has happened in the Niagara district in the last sixty years. During the period from about 1878 to 1883 or 1884 a great outbreak of yellows took place. (Little peach at this time was unknown, at least in Ontario.) The Report of the Agricultural Commission of 1881 states that many orchards were either entirely destroyed or seriously infected and that the yellows was causing something like a panic among the peach growers. Again from about 1908 to 1913 there was another great outbreak of both yellows and little peach, the latter being the more common. The senior writer witnessed this outbreak and it will still be remembered well by some of the older growers. On this occasion too there was great anxiety lest the whole peach industry might be ruined before the outbreak could be brought under control. The loss on this occasion was very great, over \$1,000,000 worth of trees having to be destroyed before control could be effected. About 1933 a third epidemic began and might have been as serious as the other two had there not been a fairly good system of inspection in force and special efforts made to check it before it had made great headway. It is not certain, however, whether all danger from this epidemic is past, though there was a decided reduction in the number of trees showing symptoms in 1936 compared with 1935. Even so this outbreak up to the present time has necessitated the destruction of 20,000 trees, a loss of \$200,000.

HOST PLANTS

Both diseases attack peaches and Japanese plums and are reported from the United States as occurring also on apricots, nectarines and almonds. Recent investigations in that country would seem to show that our native American

plums and also European varieties may perhaps at times be infected without showing any symptoms of either disease. This point, however, seems to require further investigation. Whatever be the facts about European and American varieties there is no doubt that Japanese varieties are quite susceptible and therefore an important source of danger to peaches, especially as it is difficult to recognize the symptoms on them.

In the case of peaches and Japanese plums all varieties seem to be susceptible to both diseases.

SYMPTOMS OF YELLOWS ON PEACHES

The most conspicuous symptom of yellows, and sometimes the only one on trees just beginning to show the disease, is the presence of prematurely ripened fruit on one or more branches or at times on the whole tree. These fruits ripen from one to about three weeks before the normal time for the variety and are usually a little larger than normal the first year but smaller after that. The

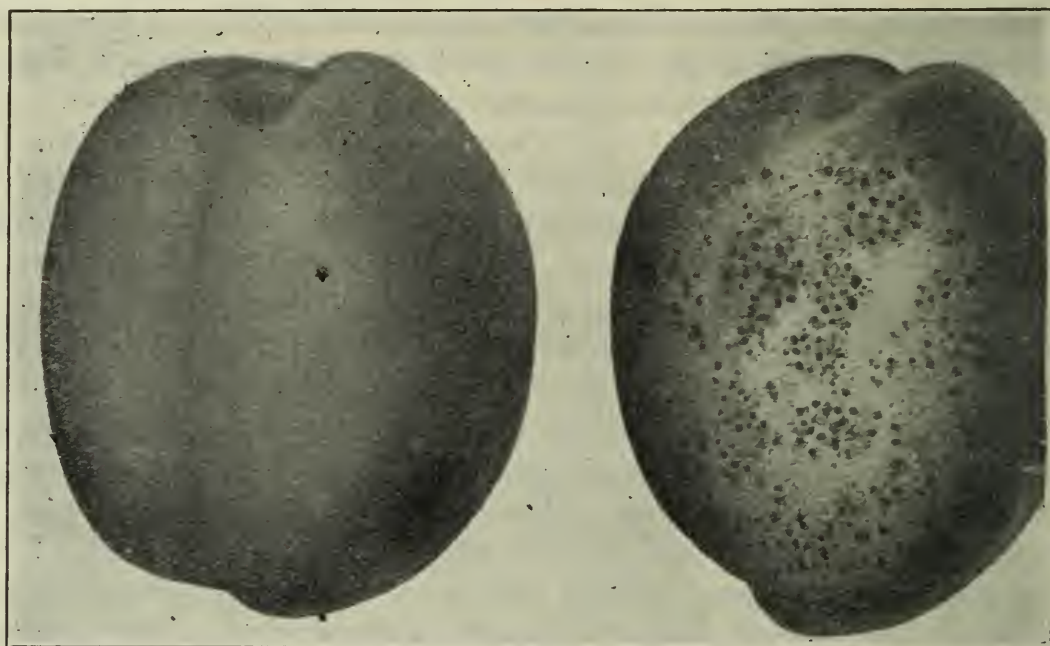


Fig. 1. Fruits from a yellows tree; the one on right is prematurely ripe and dappled with red spots; the other is still green and unripe. Usually the prematurely ripe fruit is the larger. (After Smith.)

surface is nearly always highly colored and often, but not always, conspicuously dappled with irregularly rounded spots or blotches of deep red. Some of the fruits may be knobby or bumpy, the knobs or bumps being redder than the rest of the surface. On cutting the peach the flesh is often, but by no means always, more or less reddened in places, the red color sometimes extending in streaks to the pit. Often too the flesh around the pit itself is redder than normal. There are, however, many cases in which the flesh is normal in appearance. The flavor varies greatly, sometimes being very insipid and unpalatable, at other times moderately good. It is very rarely indeed that such premature, highly colored fruits are caused by any other factor than yellows, and as they

stand out in striking contrast to the still green, smaller, normal fruit on the other parts of the same tree or on healthy trees of the same variety, they are a very simple and almost infallible proof of the presence of yellows, even though there may be only half a dozen of them on a single tree.

A second symptom of yellows is the development on the trunk, or more commonly on a main branch, of one or more little wiry growths or sprouts, characterized by their slender stems and small, narrow, willow-like pale-yellow leaves. The sprouts may be only a couple of inches high or may reach a foot or a little more. As they grow they send out fine branches close together and thus become bushy or broom-like. They always grow upright, never horizontally. These peculiar yellow, bushy growths while a very convenient means of identification of the disease, are by no means common and are found on only a very small percentage of infected trees. They seem to be limited almost entirely to trees which have been diseased for more than a year and consequently have also other foliage or fruit symptoms of yellows present.



Fig. 2. Bushy broom-like growth on yellows tree. The leaves on such growth are always yellow, small and narrow. (After Smith).

The most common symptom of yellows and the one from which it probably received its name, is the yellowish or bronze-yellow color of the leaves on one or more branches or in advanced cases on the whole tree. Little peach shows much the same color. Hence by the foliage alone it may be very difficult or impossible to state definitely which disease is present. This, of course, is not important from the practical standpoint, for both are fatal to the tree.

When studying the foliage symptoms of either disease the writers have found it very helpful to keep in mind that peach trees may be said to have two main types of leaves. One type is the straight, or nearly straight, leaf, well exemplified by Elberta, and the other is the curled-leaf, exemplified by the various Crawfords. The symptoms show up differently on these two types. On the curled or Crawford type the leaves become, as said above, yellowish or bronze-yellow and even more conspicuously curled than normally, especially towards the tips which often bend down like a claw. On the straight-leaved type the leaves are likewise yellowish



Fig. 3 Characteristic curling of Crawford type of foliage on yellows and little peach trees. The color is yellow or bronze-yellow.

or bronze-yellow but instead of curling usually droop almost as if from lack of moisture and the edges often fold upwards and inwards towards the midrib and parallel with it, thus forming a trough-like appearance. In both types of foliage, especially in the case of little peach, there is a tendency for the leaves also to cling along the branches and become more or less bunched in places, especially at the base of a watersprout. The reader, however, must always remember that clustering alone is not a symptom of either yellows or little peach unless the leaves in the cluster have the characteristic sickly yellow or bronze-yellow color, for leaves on vigorous growing healthy trees, especially of the curled-leaf type, sometimes cluster.

Another foliage characteristic of both yellows and little peach is that unless the trees have been diseased for a year or more the foliage at the tips of the affected branches for a few inches to a foot back is still quite green in contrast with the characteristic yellowing of the foliage below it on the same branches.

SYMPTOMS OF LITTLE PEACH

As the name suggests the fruit on trees infected by little peach is usually smaller than normal. It is also in most cases from one to about three weeks later in ripening. The smallness of the fruit when taken in conjunction with the foliage symptoms described below, is a valuable aid in making diagnosis easier, but by itself is not to be relied upon because it may be brought about by other factors such as poverty of the soil, drought, or injury to the roots or trunk, or even by the individuality of the tree itself.



Fig. 4. Branch on left from tree diseased with little peach, on right from healthy tree of same variety. Note smaller fruit and more clustered foliage on the former. (Photo by G. Dustan.)

The main symptom of the disease and the one that must chiefly be relied upon, is the appearance of the foliage. As already mentioned, the foliage symptoms of yellows and little peach are very similar. The writers consider, however, that in most cases these show up a little more clearly and definitely on little peach trees than on yellows. Briefly restated, they are, the yellowing or bronzing of the leaves, and the bunching or clustering of these here and there; and also the fact that the terminal leaves on the outer part of the tree are usually green from the tip back for about four to twelve inches, in contrast with the yellowish color of those lower down.

There are no twiggy or broom-like growths on little peach such as are fairly common in the case of yellows.



Fig. 5. Healthy Elberta branch showing normal foliage.
(Photo by G. Dustan.)

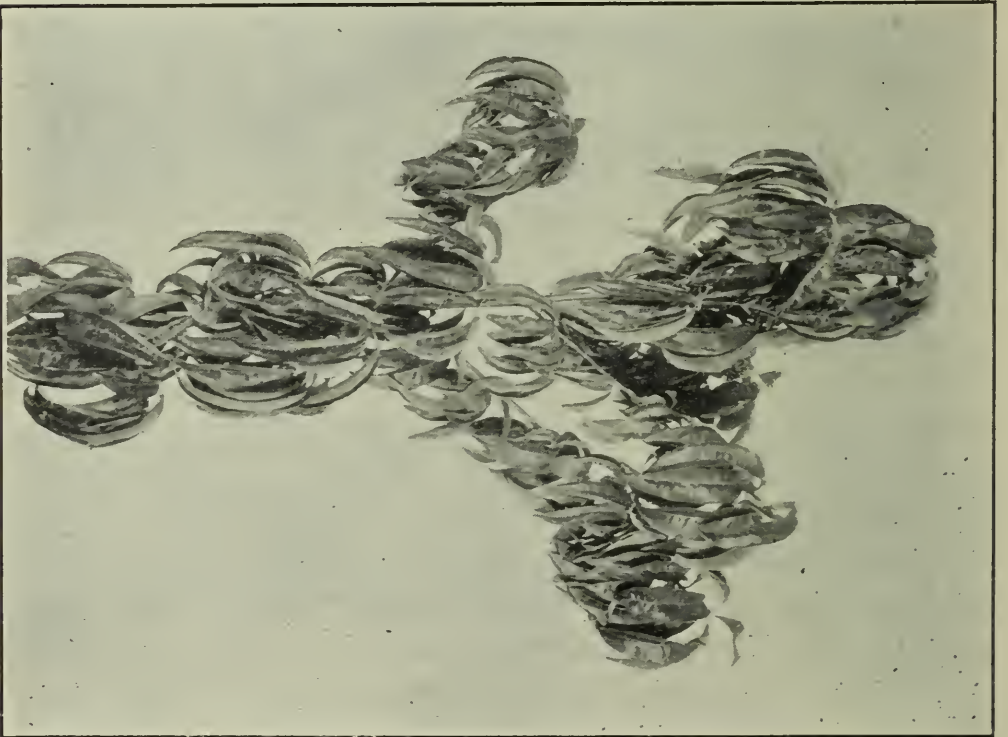


Fig. 6. Elberta branch infected by little peach. Note drooping of foliage and way it clusters along the branch. It is yellowish in color versus the deep green of a healthy foliage. (Photo by G. Dustan.)

SYMPTOMS ON JAPANESE PLUMS

The characteristic symptoms of yellows and little peach as described for peaches are often difficult to recognize or not present on Japanese plums. The safest course to follow in the case of these is to consider the trees diseased and a source of danger once their foliage becomes stunted and sickly in color, and the fruit abnormally small.

YOUNG PEACH TREES AND THE DISEASES

It is interesting to know that with rare exceptions neither yellows nor little peach shows up in young trees until three or often four years after they have been set out in the orchard. Why this is so is not known at present. After they reach the age of four years these diseases may continue to show up here and there as long as the orchard remains.

WHICH DISEASE IS THE MORE COMMON

Up to about the year 1895 or possibly 1900 yellows seems to have been the only disease present, but around this date little peach was introduced and by the year 1908 had become more abundant than yellows and has remained so in most orchards up to the present time. Our observations would lead us to the conclusion that at least five trees are today infected with little peach to one with yellows. There are, however, some orchards in which yellows is in the majority.

OTHER FACTORS CAUSING SYMPTOMS LIKELY TO BE MISTAKEN FOR THOSE OF YELLOWS OR LITTLE PEACH

Peach trees to thrive require good cultivation of the soil and a liberal supply of plant food. Hence if the soil is not well cultivated or if any of the necessary food elements, especially nitrogen, potash, or phosphoric acid, is deficient the foliage will become yellowish or reddish-yellow and often have jagged margins. Poor drainage is also a common cause of pale-colored foliage. Sometimes mottled leaf, which may easily be confused with yellows or little peach, is associated with poor drainage, but there are probably other factors also responsible for mottled leaf. Other causes of sickly-looking foliage are—cankers on the branches or trunks, borers at the crown, and winter killing of trunks or roots. Any of these may shut off the normal supply of sap and therefore affect the foliage. However it is usually fairly easy after a little experience to distinguish between the symptoms of any of these and those of yellows or little peach. One means of distinction is the fact that the sickly yellow color in these trees nearly always extends all over the affected branches or whole tree, right to the tips, whereas the peculiar coloring of yellows or little peach, except in far advanced cases, usually does not extend to the tips, which remain green for a few inches back. Moreover the curling or drooping and clustering of the leaves, characteristic of yellows and little peach, seldom occur from any of the other factors mentioned. Still another helpful means of distinction is that foliage affected by yellows and little peach does not tend to drop, while it does in the case of some of the other factors.

CAUSE OF YELLOWS AND LITTLE PEACH

All the research work done up to the present tends to show that both diseases are caused by what is commonly called a virus. No one has ever been able, even with the most powerful microscope, to see a virus and yet many diseases, especially those characterized by yellowish or mottled foliage, are known to be caused by them. Good examples are—the mosaic disease of raspberries, potato mosaic, sweet pea mosaic, and tobacco mosaic. Unlike fungi and bacteria, which are usually restricted to the foliage and fruit or to individual parts of the tree, a virus once it has infected a tree quickly spreads all through the living tissues and therefore cannot be controlled by any spray or by cutting out the parts which happen to show the symptoms.

METHODS OF DISTRIBUTION

There have been many theories as to the way in which yellows and little peach are distributed. Some persons think that the nurserymen spread it by using pits from diseased fruit or by getting their bud-sticks from trees which are diseased but do not show the symptoms clearly. Others think it may be spread by pruning tools when pruning the orchard. Others claim that if a diseased tree rubs against a healthy tree it will give the disease. Others feel sure that insects are responsible. There are still other theories than the above. All these theories have been tested by different investigators and it has been proven that the use of diseased pits does not cause the disease, neither does rubbing the bark of a diseased branch against a healthy branch until both are ruptured, nor even inoculating

the juice from a diseased tree into a healthy, nor do pruning tools spread them. There are only two known and proven ways of distribution. The first is by inserting a bud or scion or a section of bark from a diseased tree into a healthy, and the second by a certain leaf hopper (*Macropsis trimaculata* Fitch) feeding first on diseased trees and then passing to healthy trees. It is possible that one or more other species of insect may also be carriers, but out of 47 tested this was the only one found able to do so.

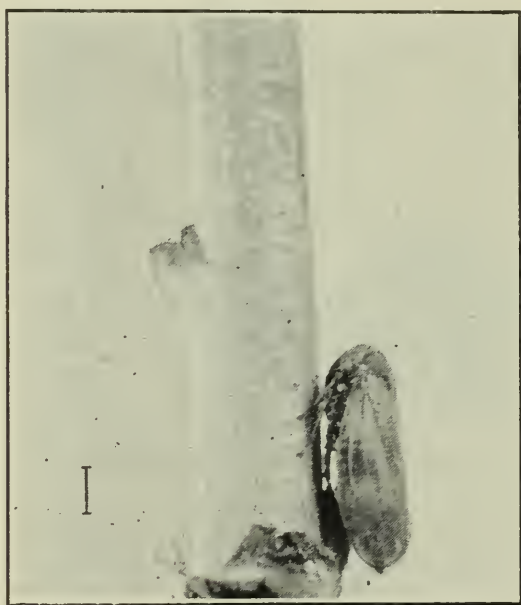


Fig. 7. Plum leaf hopper which spreads yellows and little peach. The length in nature is about three-sixteenths of an inch and the color a dull reddish-brown. The black line on the left indicates the natural size.

(Photo by Armstrong through courtesy of Mr. W. A. Ross)

From the above it will be seen that nurseries, if once contaminated, may spread either disease. The indications, however, are that only a few infected trees come from the nursery and that most of the distribution takes place in the orchard itself probably through the leaf hopper. This insect is stout, dull

reddish brown, and about three-sixteenths of an inch in length when full grown. It has sharp piercing and sucking mouth parts and with these both adults and nymphs penetrate the bark and feed on the juice. Its favorite host is the plum, especially wild plums, but it attacks also peaches. There is only one brood in a year and the winter is passed in the egg stage in the bark of plums and peaches.

LENGTH OF THE INCUBATION PERIOD

It requires longer for yellows and little peach after they are inoculated into a tree by budding or by plum leaf hoppers to show the symptoms than for most diseases. The shortest time in the orchard is one year and often two are required.

CONTROL

In discussing control we must remember that once a tree is infected there is no cure for it and that as long as it is left in the orchard it is a potential source of danger to the rest of the trees. Hence the first step in control, and the most important, is to mark all diseased trees in all the orchards as soon as possible and see that they are taken out promptly. To get this done it is necessary that we have inspectors. The Plant Diseases Act states, "The council of any municipality may, and upon receipt of a petition signed by at least twenty-five ratepayers, the council of any township or county shall, by by-law appoint one or more inspectors to enforce the provisions of this Act and the regulations in such municipality." These provisions or regulations require the marking and removal within ten days of all trees diseased with yellows or with little peach. Failure to carry out the regulations leaves the offender liable to prosecution and fine.

The inspectors are under the supervision of the Provincial Entomologist and the Provincial Plant Diseases Inspectors. They do not begin their work until about the end of July because the fruit symptoms and usually also the foliage symptoms do not show up clearly enough until that date to justify their beginning sooner.

As it requires several weeks for an inspector to cover all his territory it is clear that every grower should himself study the symptoms of the diseases and mark and remove his own trees without waiting for the inspector so that there will be less time for any spread from these to take place. The inspector when he comes will go over the orchard to see if any trees were missed. Many of our best growers are already doing most of their own inspection, with excellent results.

It is not difficult for a peach grower, unless he has poor eyesight or is color-blind, to learn how to detect yellows and little peach. He must of course read carefully the symptoms of both diseases as given above and also what has been said about other factors which cause foliage symptoms likely to be mistaken for yellows or little peach. The inspectors will be glad to give any help they can,

if the grower cares to spend some time with them in the performance of their duties. Beginners should commence their study in well cultivated and well fed orchards because in these the foliage symptoms show up in sharper contrast with the normal rich green foliage of surrounding healthy trees. After practising in these orchards they may then profitably try identification in poorly fed or poorly cultivated orchards in which the foliage is more or less off color and thus harder to differentiate from that on diseased trees.

As all infected trees will not show up the diseases clearly in the first round every orchard should be inspected at least twice and the worst ones three times. The last inspection should be done in September. At the end of the season the inspectors should make a rapid run over their territory to make sure that all marked trees have been removed. Great strictness is necessary on the part of all the inspectors both in marking and in insisting upon the prompt removal of the diseased trees for otherwise their work will be largely nullified.

Japanese plums must of course be inspected as well as peaches.

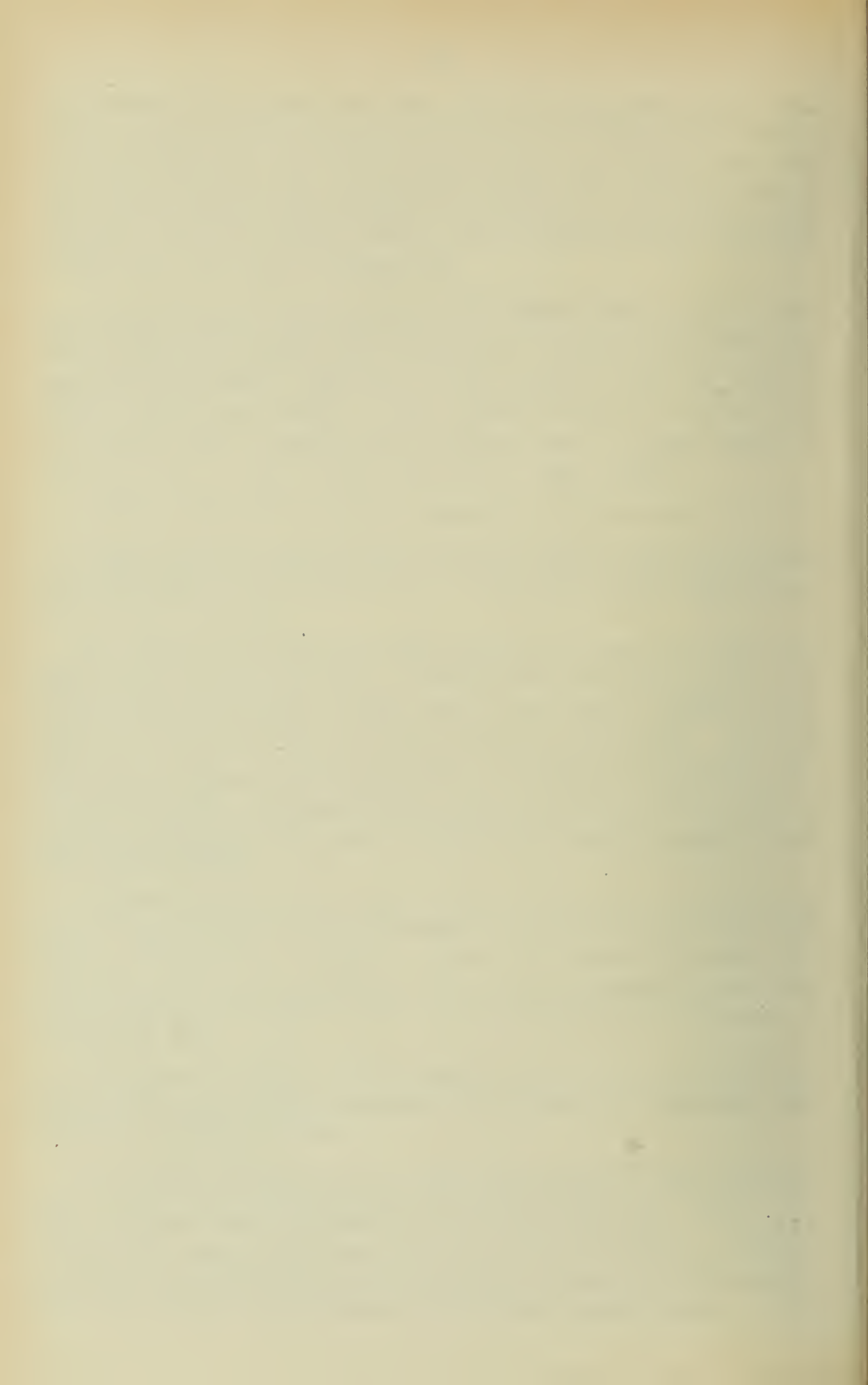
Inspectors are often asked whether it is safe to plant a new tree in the hole left by the removal of a diseased one. It is quite safe, for the disease cannot be contracted by so doing.

On account of the plum leaf hopper being able to spread the disease and plums being its favorite host plant, it would be wise when setting out new trees to keep plums and peaches a hundred yards or more apart if possible, so that this insect may be less likely to go from the plums to the peaches. It would also be wise to spray the plums and the part of the peach orchard nearest them with nicotine sulphate 1 pint and soap 5 lbs. to 100 gals. of water, to kill the young leaf hoppers. This should be done about the first week in June, that is just after the eggs have all or nearly all hatched and while the nymphs are still small and easily killed.

Another important step in control is that all nurserymen make sure that their bud-sticks come from orchards which are known to be free from both diseases. The writers are willing to examine any orchard from which any nurseryman wishes to get bud-sticks, and if it has any diseased trees will find another orchard for him which is clean. Several nurserymen took advantage of this offer last year.

The control of yellows and little peach, as inferred from what has been said, depends upon the full co-operation of the growers, the inspectors, their supervisors, and the nurserymen.

In conclusion all growers will be glad to learn that the Federal entomologists and plant pathologists stationed in the Niagara district, have begun a very thorough study of these two diseases and of the plum leaf hopper. The study will doubtless require a good many years but we hope that the results will aid us greatly and perhaps make it possible gradually to exterminate the diseases. The writers will give any assistance in this work that time may permit.



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BULLETIN 384)

(MARCH, 1937

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

BEE DISEASES

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VIEW OF APIARY
ONTARIO AGRICULTURAL COLLEGE

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BEE DISEASES

INTRODUCTION

Diseases of bees are divided into two main classes, namely, brood diseases and those which attack the adult bee. Although adult bee diseases have caused great damage in sections of Europe, so far they have not been serious in any parts of North America.

The three important brood diseases of Ontario are American Foulbrood, European Foulbrood and Sacbrood. In general these diseases have quite similar characteristics. Whereas European Foulbrood and Sacbrood are easily controlled, there is no cure for American Foulbrood. To avoid serious losses it is essential that beekeepers become sufficiently informed to correctly diagnose all three diseases.

Through the destruction of infected colonies American Foulbrood causes an annual loss of about four thousand colonies in Ontario. Besides the loss in bees, honey and equipment, many beekeepers become discouraged and sell their bees or, which is worse, neglect their colonies, leaving them as a source of infection to other people's bees. Although some parts of the Province have suffered from disease more than others, no area is outside their range.

Due to the inspection system in Ontario, disease has been held in check and beekeeping on a commercial scale is made possible. Complete eradication, however, can never be attained until every beekeeper becomes his own inspector. It is the aim of this bulletin to place before the beekeeper in a clear and simple form the essential facts regarding identification and control of bee diseases. Do not let disease destroy your colonies while waiting for the inspector. Learn symptoms and keep the colonies disease-free at all times. If not sure of your diagnosis, send a smear to the Apiculture Department, as explained later.

EXAMINATION OF COLONIES

Control of disease is best effected by giving the colonies two thorough inspections each year. The first examination should be made in the spring at the beginning of the fruit bloom and dandelion flow before the first super is added. If disease is controlled at this time the loss of one or more supers is avoided. In addition to this, the disease does not get a chance to spread to other colonies and cause trouble later on in the season when there is surplus honey in the hives. Any infection picked up by bees robbing diseased colonies during the fall and early winter is usually evident and may be brought under control before it spreads too far.

A second thorough examination is advisable during the summer just prior to the removal of the light honey crop, particularly where disease is suspected in the supers. When the bee escapes are being placed on the hives, very little additional effort is required to examine the brood combs. Finding disease at this time allows the beekeeper to keep diseased supers away from clean equipment. Colonies having disease during the fall will likely die before spring and act as a potent source of infection to other colonies.

Detection of disease is much easier on a bright day. When examining a frame shake most of the adhering bees into the hive. By standing in such a manner that the sun shines into the base of each cell, little difficulty will be experienced in detecting abnormalities of the brood. A thorough

examination in the above manner should always be given before inter-changing frames of brood or honey with another colony.

Prevention of robbing from dead and weak colonies in the early spring is one of the most important duties of a beekeeper in the control of disease. All dead colonies should be examined on the first visit to the yard, and diseased colonies destroyed. If this is not possible, dead colonies should be made absolutely bee-tight, or, more preferably, removed from the yard. It is believed that much disease is spread by robbing from dead colonies in the spring.

It is impossible to control disease if colonies are kept in box hives. Infection cannot be detected unless combs are removable. Box hives are therefore a menace to the industry. The Foulbrood Act demands that all bees in such hives be transferred to movable frame hives.

NORMAL DEVELOPMENT OF HEALTHY BROOD

There are two types of insect development. In the case of the grasshopper for example, the egg hatches into a young insect or nymph very similar in appearance to the adult. This is called incomplete metamorphosis. The second type of development, under which the honey-bee is classed, is called complete metamorphosis. The honey-bee egg develops into a small white grub or larva. This later spins a fine cocoon and goes into the pupal or transition stage from which it emerges a fully developed bee.

In order to detect unnatural conditions of the brood the beekeeper must know the life history and the appearance of healthy brood at every stage of its development. A study of the life history chart in conjunction with Figure 1 will give the story of this development.

AVERAGE LIFE CYCLE OF THE HONEY BEE

Stage	Queen	Worker	Drone
Egg -----	3 days	3 days	3 days
Larva -----	5½ days	6 days	6½ days
Pupa -----	7½ days	12 days	14½ days
Total -----	16 days	21 days	24 days

The egg of the bee is a small, white cylindrical object about 1/10 of an inch long, somewhat larger at one end (future head end) and slightly curved. It is deposited on the base of the cell by the queen and is fastened in place by a secretion.

The larva, at first very small, grows rapidly, and in a few days occupies the whole of the base of the cell. The healthy larva before being sealed lies curled up in the base of the cell and is a glistening pearly white colour, with the segmentation of the body clearly shown. Three or four days before the larva actually transforms to the pupal stage, the cell is sealed by the nurse bees. The curled larva straightens out in the cell and spins a thin cocoon preparatory to transformation to a pupa. Figures "a" and "b" show the egg and larval stages before capping, "c" and "d" the larval and pupal stages after being sealed.

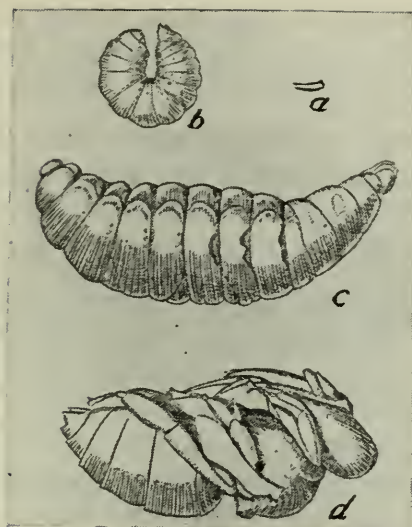


Fig. 1.

The honey bee: a, Egg; b, young larva; c, old larva; d, pupa. Three times natural size. (U.S. Dept. of Agr. Farm Bulletin 447.)

AMERICAN FOULBROOD

The term "American" is used simply to differentiate this disease from other brood diseases. It does not imply either origin or location of the disease.

(a) SYMPTOMS

Appearance of diseased comb. If disease has been present in a colony for some time the comb will assume a mottled or pepper-box appearance. This is caused by open cells containing dead larvae or scales being interspersed with normal brood. This mottled effect is also characteristic of other diseases.

Condition of cappings. Normal healthy cappings are light brown in colour, becoming slightly darker with age. They are somewhat rounded or convex in shape. If a diseased larva or pupa is present in the cell the capping frequently becomes sunken and dark brown in colour. Many cappings are perforated with one or two small holes by the bees as though they were investigating the tardy emergence of the brood.

Time of death. Death occurs from American Foulbrood almost invariably two days before or two days after the transition to the pupal stage at which time the cells are capped.

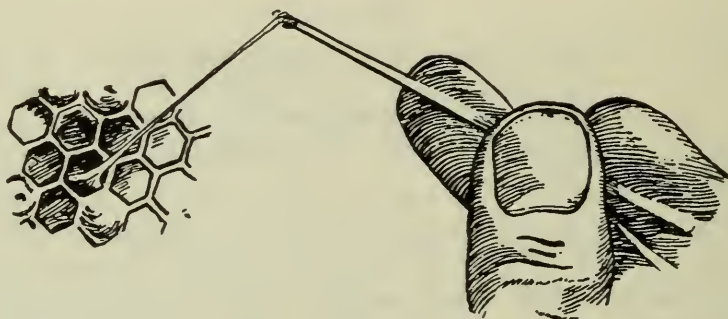
Position in the cell. Larvae lie curled in the cell at the time capping takes place. After the cell is sealed the larva straightens out, lying flat along the bottom of the cell. Three to four days after capping the change to a pupa takes place. It is within two days either before or after this transformation that death occurs. Due to the uniform position in the cell at this time the decaying brood settles in a regular uniform mass, to the bottom of the cell. This characteristic is contrasted to European Foulbrood where the decaying brood is usually twisted in the cell.

Colour changes. Healthy larvae are pearly white in colour. Decay-

ing larvae dead of American Foulbrood are first a light yellow brown. As they settle down in the cell the colour changes gradually to a dark, coffee brown, which is of uniform shade over the entire body surface.

Appearance of affected pupae. Pupae dead of the disease go through the same process of decay and settling and similar colour changes as the larvae. The tongue of the pupa is nearly always extended towards the top wall of the cell. This is a definite sign of American Foulbrood.

Ropiness of American Foulbrood. American Foulbrood destroys the larval or pupal tissue. The body wall soon becomes soft and easily ruptured. Dead brood passes through several stages of decay, each stage varying in colour, shape and consistency. After about three weeks of decay, until the scale is formed, a characteristic ropiness is exhibited. During this period a toothpick inserted into the mass will draw out a fine gluey thread of decaying matter. (Fig. 2.)



The ropiness of American Foulbrood
(U.S. Dept. Ag., Far. Bul. 442)

Although this ropiness is a definite characteristic of American Foulbrood, it should be remembered that it only occurs at a certain stage of putrefaction. When a suspicious cell is found during inspection, all other symptoms should be carefully observed before inserting a toothpick and destroying the larva or pupa for further inspection. Too many beekeepers have the habit of inserting a toothpick immediately they see a suspicious cell.

This destroys other important symptoms.

American Foulbrood odour. In the early stages of American Foulbrood no odour is evident. In advanced stages, however, where much brood is dying and the disease has been present for weeks, the odour is quite distinct. The smell is characteristic, but is probably best described as resembling that of heated glue.

The value of odour is overlooked by many experienced beekeepers. Even when a small amount of infection is observed a diseased larva may be removed on a match or toothpick and an effort made to detect the characteristic odour. Some people have a very highly developed sense of smell and with such this point is a great help in diagnosis.

Formation of a Scale. After four to five weeks the decaying brood dries down to a hard dark scale. American Foulbrood scales are characteristically uniform in shape, covering the greater portion of the lower cell wall and extending part way up the back wall. The scale adheres tightly to the cell and cannot usually be removed without tearing the cell wall.

(b) CAUSE OF AMERICAN FOULBROOD

In 1902 Dr. G. F. White, United States Department of Agriculture, first demonstrated that the disease was caused by a bacteria which he named *Bacillus larvae*. Certain bacteria have the ability to form a protective covering around themselves. In this stage, called spores, they are capable of existing for long periods away from their host. *Bacillus larvae* is a spore forming bacteria. It will live for years in honey and will often withstand boiling in water for twenty minutes. This spore forming characteristic makes *B. larvae* very difficult to exterminate.

(c) METHOD OF INFECTION

When honey is stored in cells containing scale the spores of American Foulbrood become dispersed through the honey. Larvae fed with this diseased honey become infected and death occurs a few days later. Thus the cycle is maintained.

(d) METHODS OF SPREAD

American Foulbrood is spread chiefly by robbing infected honey from diseased colonies, either dead or alive. Great care should be taken to see that dead or weak colonies are not robbed out in the spring. The entrances of these colonies should be closed or the hives removed to a bee-tight dwelling about the first of April. This precaution is extremely important. It is possible for one diseased colony to infect a whole apiary. Infection may also be carried from one hive to another by drifting of the nurse bees, especially during manipulation of the colony. Great care should be taken in interchanging combs from one hive to another. Stray swarms should be hived on foundation rather than on drawn comb. Then if diseased honey is present in the crops of the swarming bees it is used up in drawing out the foundation, rather than being stored and later fed to the larvae.

Bee trees are often given too much credit for the spread of disease. Although colonies in trees may spread American Foulbrood, such swarms which become weakened and die from disease do not long remain a menace. They are soon cleaned up by wax moths, ants and other insects or animals.

(e) IMMUNITY TO AMERICAN FOULBROOD

Although workers are most commonly infected, drones and queens are also susceptible to the disease. From the results of experimental inoculations and beekeepers' experience it appears that no race of bees possess any marked immunity to the disease.

(f) ERADICATION OF AMERICAN FOULBROOD

The old shaking treatment, whereby the bees of a diseased colony are shaken on to foundation and thus saved can no longer be advocated. In fact, it has been found that the treatment in general tends to spread disease rather than eradicate it. When combs are shaken there is a tendency for young nurse bees, not having marked their location, to fly into nearby hives carrying diseased honey with them. Another criticism of the treating system aside from general spread of disease at the time of treatment is that diseased combs are often stored for some time before

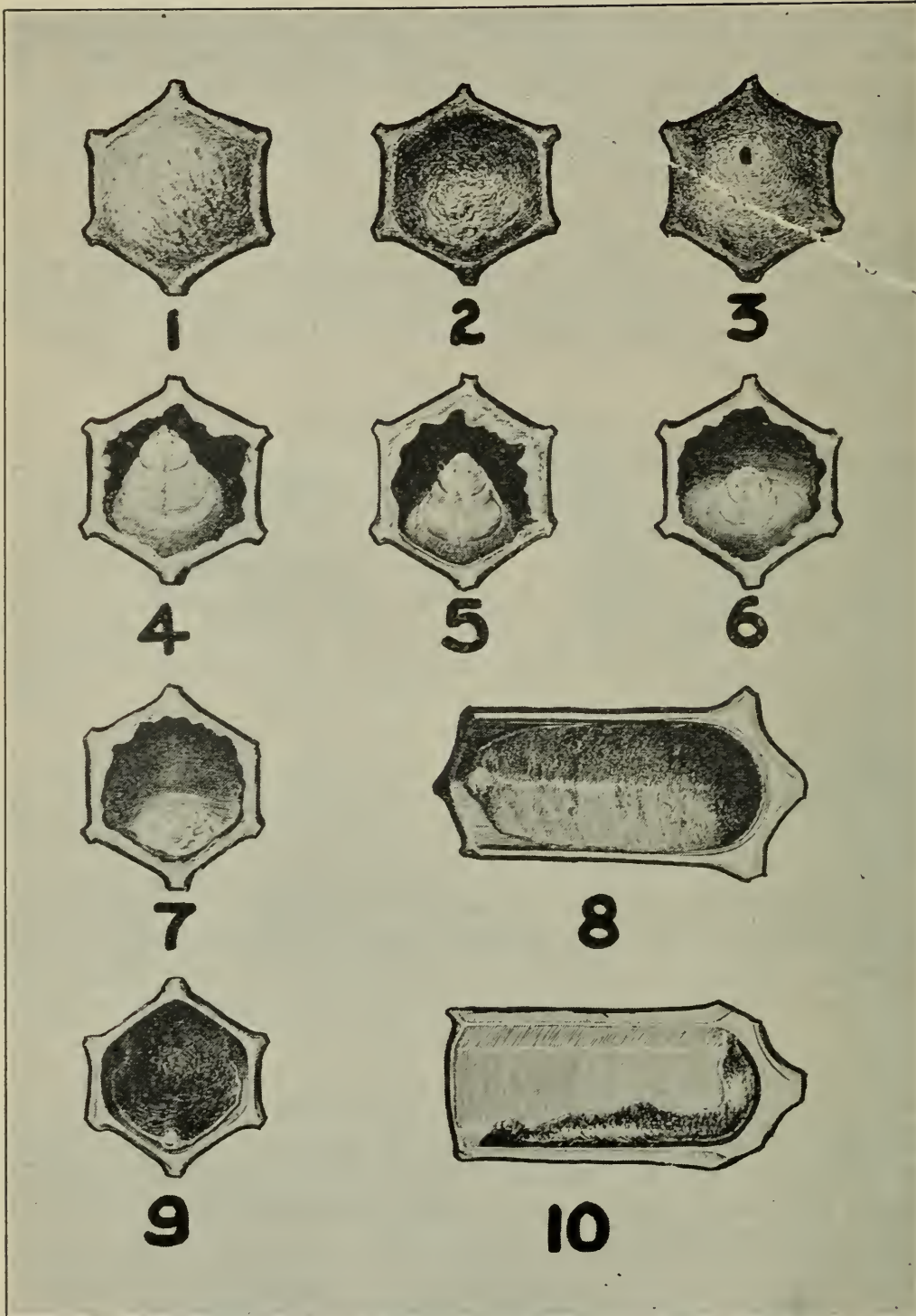


Plate 1.

American Foulbrood death occurring in the larval stage: 1. Healthy capped cell; 2, 3. Capped cells containing dead larvae; 4, Healthy larva; 5, 6, 7, 8. Progressive decay; 9, 10. dry scales.—(Reproduced from U.S.D.A. Bulletin 809.)

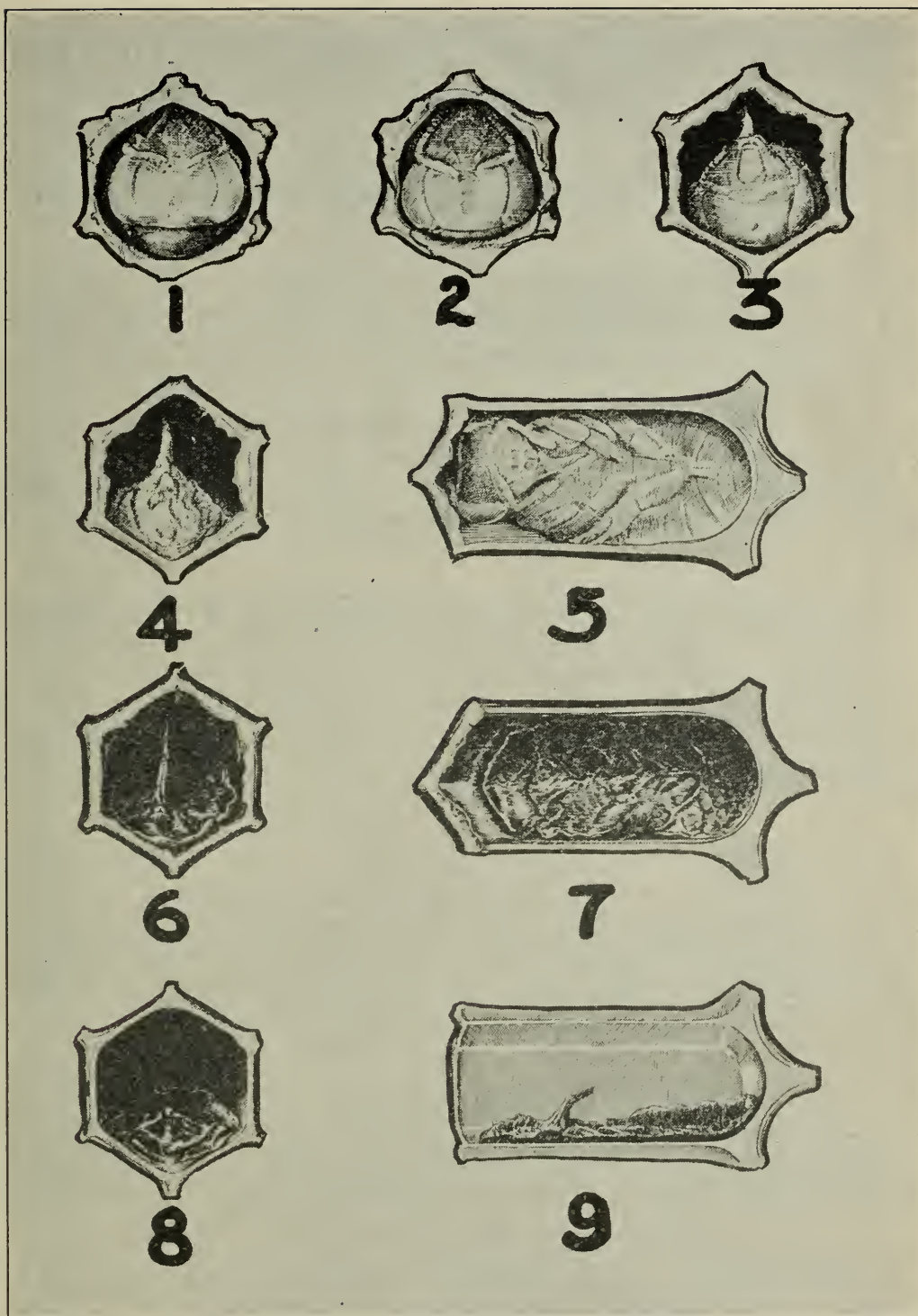


Plate 2.

American Foulbrood, death occurring in the pupal stage: 1. Healthy pupa; 2, 3, 4, 5, 6, 7. Progressive decay of dead pupae; 8, 9. Dry scales.—Reproduced from U.S.D.A. Bulletin 809.)

being rendered. This is very dangerous as there is always a grave danger of infection by bees robbing stored combs. The treating plan proved to be false economy. It is cheaper to kill diseased bees and make increase from healthy colonies.

Burning diseased colonies. The only known method at present by which American Foulbrood may be completely stamped out is by burning the bees and combs and sterilizing other parts of the hive by fire. Disease has been entirely cleaned up in restricted areas by this plan and there is every reason to believe it could be completely eradicated from the Province. Immediately the disease is found it should be destroyed. Delay is generally costly.

Considerable work has been done in an effort to find some drug or chemical that would effectively cure a colony of American Foulbrood. So far there has been no success along this line.

STEPS IN ERADICATING AMERICAN FOULBROOD

1. Inspect the colonies giving each frame a thorough examination. If disease is found, mark the colonies carefully so there will be no possible danger of overlooking them later.

2. Dig a hole in the ground large enough to accommodate all the combs. Unless the hole is large diseased honey will be spilled around the surface of the soil and spread disease. Do not dig the hole too near a tree or the fire will wilt the leaves and injure the tree. Allow for the wind and be sure the fire is situated where there is no danger of spreading. Place some rough chunks of wood in the hole to ensure a good draft and sufficient fuel to thoroughly consume all diseased material.

3. Kill the bees. In the past gasoline was used for this purpose but it is not at satisfactory as cyanogas, which is a commercial preparation of cyanide in powder form. When gasoline is used the bees fly from the hive unless the entrance is closed. Cyanogas kills the bees without their realizing any danger. Field bees will also fly into the hive. When using cyanogas sprinkle a dessert-spoonful on top of the frames and a little in the entrance to catch the incoming bees. Five minutes is long enough to leave the colony after adding the cyanogas, otherwise many of the bees recover as the powder becomes spent and the gas drifts from the hive. Great care should be taken when using this poison as a few good breaths might easily prove fatal. There is no necessity to wait until evening to kill the colonies.

4. Light the fire. It is advisable to use coal oil and get a good strong flame so the diseased material may be disposed of as quickly as possible.

5. Carry the hives complete to the fire and throw on the combs. Be sure no dead bees drop from the entrance as most of them exude a drop of honey which sticks to their tongues and may be diseased. If the combs are heavy with honey keep the fire well bolstered up with chunks of wood.

6. Scrape thoroughly and disinfect by scorching all boxes, bottom boards and covers. Covers and bottom boards may be sterilized by

holding them over the fire for a few seconds, on a fork or long stick. Boxes may also be treated in this manner or else piled one on top of the other sprinkled inside with coal oil or gasoline and ignited. The flame may be extinguished by placing a cover on the top box, thus excluding the air.

7. All dead bees and other debris that might carry infection should be scraped into the fire. When everything has burned down to an ash, fill the hole in thoroughly.

8. Hive tools should be disinfected with fire and the hands washed with soap and water before examining other colonies.

DISEASE IN SUPER COMBS

Chemical treatments such as the use of formalin, chlorine, etc., which were once recommended for diseased super combs have been definitely proven unsatisfactory. If a beekeeper is suspicious of his super combs the best practice is to render them into wax and have it made into foundation. The actual cost of this procedure is not great and it is considered sound economy by many successful beekeepers.

EUROPEAN FOULBROOD

Less than forty years ago this disease caused the beekeeping industry considerable anxiety. It spread with remarkable rapidity, wiping out whole apiaries. Today beekeepers have learned that it can be easily controlled by keeping the colonies strong and using resistant Italian stock. It is no longer a menace to the industry.

(a) SYMPTOMS

The appearance of larvae dead of European Foulbrood varies considerably and the symptoms are more variable than those of American Foulbrood. Always keep in mind the appearance of healthy brood when inspecting for indications of disease.

Appearance of comb. The presence of many uncapped cells, containing disease larvae in the early stage of development, gives the comb a spotted irregular appearance. Should the majority of larvae die at a later stage of development after the cells are sealed, the cappings are sunken, perforated and decidedly greasy in appearance.

Time of death. All larvae die before the transformation to the pupal period. About ninety percent die one or two days before the cell is capped. Probably ten percent die the first or second day after capping, i.e. when the larva is beginning to straighten out in the cell preparatory to its transformation to the pupa. Occasionally an outbreak of European Foulbrood takes place where colony after colony contains larvae most of which are attacked at this later stage. This type is often confused with American Foulbrood. The variability displayed in time of death makes diagnosis more difficult. In typical European Foulbrood, however, the cell is uncapped.

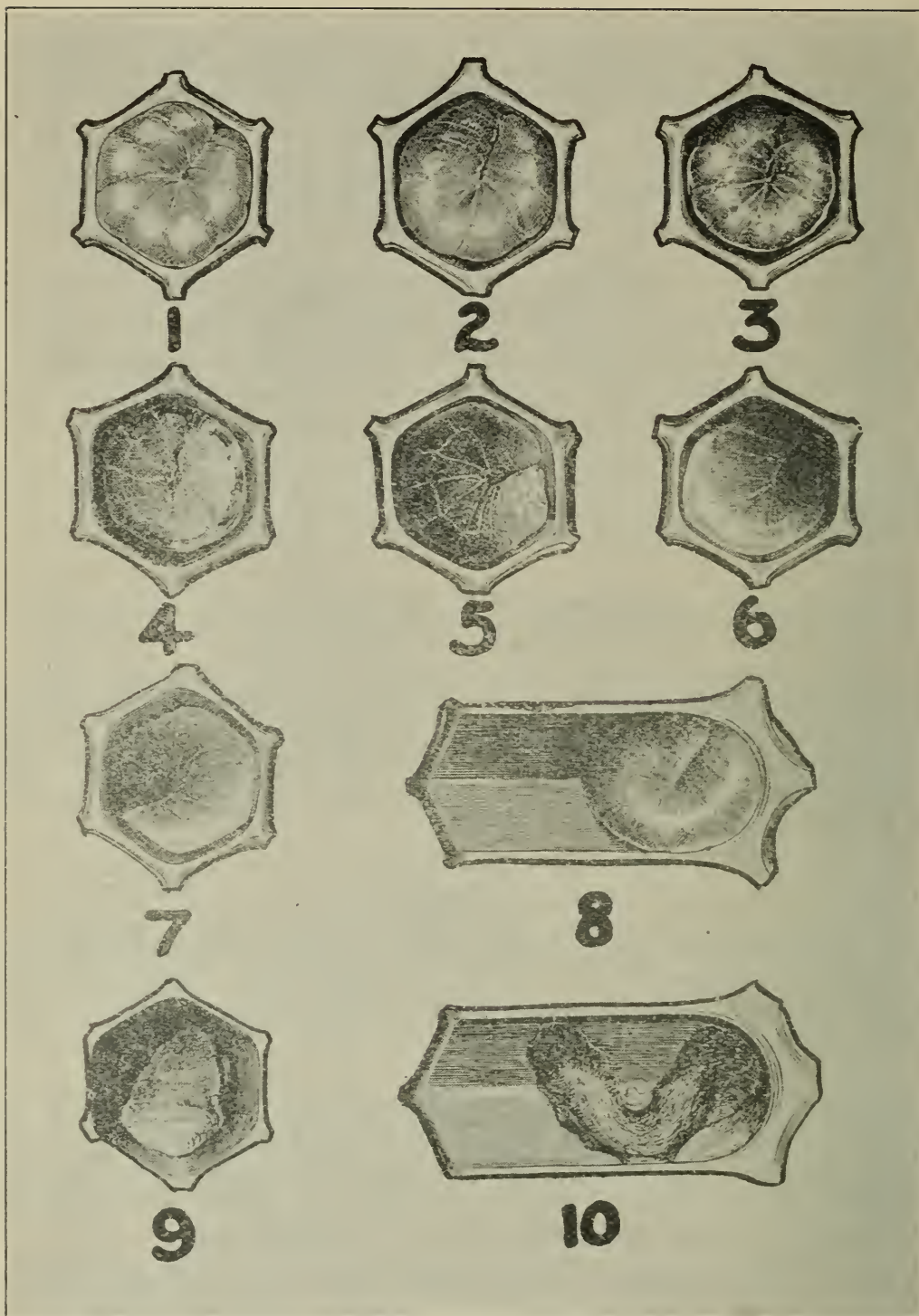


Plate 3.

Characteristic European Foulbrood, death occurring in the early larval stage: 1. Healthy curled larva; 2 to 10. Various stages of decay; 4, 5. Shows tracheae; 6, 7. Larva twisted in cell; 9, 10. Dried out scale.

—(Reproduced from U.S.D.A. Bulletin 810.)

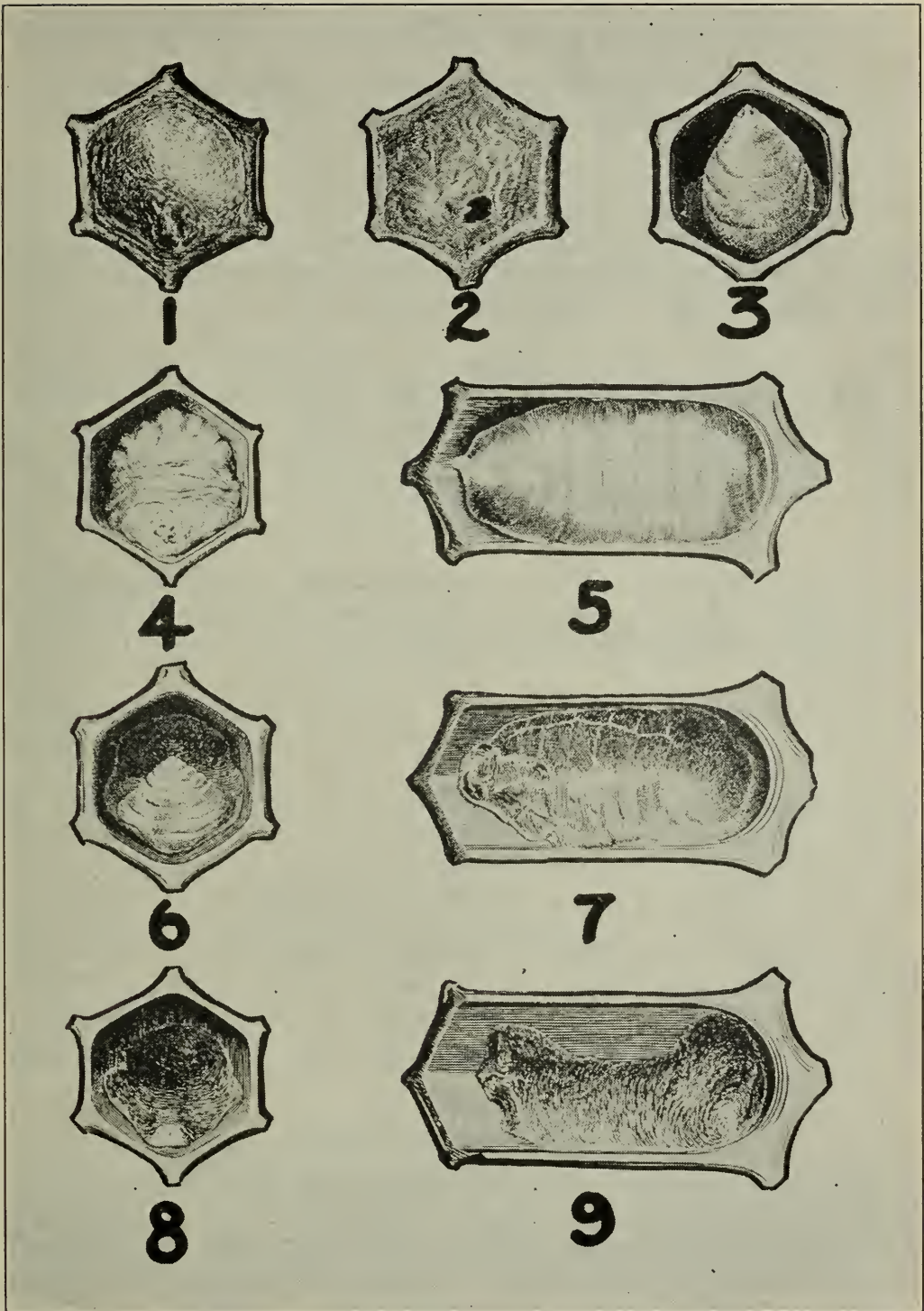


Plate 4.

European Foulbrood, death occurring in the late larval stage: 1, 2. Capped cells containing larvae dead of European Foulbrood; 4. Dead larvae showing part removed by the bees; 3, 5, 6, 7. Various stages of decay; 8, 9. Dried out scales.—(Reproduced from U.S.D.A. Bulletin 810.)

Position in the cell. Larvae exhibit marked variation in their position according to the age at which they die. Young larvae dying at the characteristic stage while still curled generally squirm around as though in pain assuming unnatural positions in the cell. Those larvae that die after capping are larger and lie more uniformly extended in the cell.

Colour changes. The pearly white colour of healthy larvae changes to greyish yellow. As putrefaction continues the colour deepens to a dark greyish brown mass.

Consistency of dead larva. After approximately three weeks of decay the larva becomes a sticky, somewhat granular mass. The granular appearance at this stage is contrasted to the smooth glue-like appearance of American Foulbrood.

Tracheae visible. The tracheae are glistening, silvery air tubes situated below the skin. In many larvae dead of the disease these tracheae may be plainly seen and remain visible during the complete process of putrefaction. The presence of tracheae is an important symptom to differentiate infection in the advanced larval stage from American Foulbrood.

European Foulbrood odour. In advanced cases, especially where many larvae die in the capped over stage, there is a very offensive odour. It is described as resembling that of rotten fish.

Scale formation. The dried larval remains are less brittle and more rubber-like than American Foulbrood scales. They are shrivelled, brown in colour and can easily be removed from the cells. The fact that brood dead of European Foulbrood can be removed by the bees makes it possible for strong colonies to clean up the disease.

(b) CAUSE OF EUROPEAN FOULBROOD

Bacillus pluton, a non spore former, is considered to be the organism which actually causes the death of the larva. Invariably, however, there are secondary organisms present, the chief of which is *Bacillus alvei*. When a laboratory diagnosis is made the presence of *Bacillus alvei* indicates European Foulbrood.

(c) METHODS OF SPREAD

The organism causing European Foulbrood does not form spores so is unable to live over winter in honey. It is carried over in pieces of dead larvae. From this small beginning in the spring it can spread very rapidly under favourable conditions. If nectar is stored in contaminated cells and fed to larvae they contract the disease. Further spread may be caused by robbing, interchanging combs or drifting nurse bees.

(d) IMMUNITY TO EUROPEAN FOULBROOD

Workers, drones and queens are all susceptible to European Foulbrood. Italian bees, due to their vigorous house cleaning habits, stop the spread of disease and eventually eradicate it. Some strains are far more efficient in cleaning out dead larvae than others. Black bees are very susceptible to the disease.

(e) ERADICATION

European Foulbrood has not caused very serious trouble since beekeepers have learned the present preventive measures. Most definite progress in its control has been made through Italianizing all colonies and breeding queens from resistant stock.

It must be remembered that European Foulbrood is a disease of weak colonies. The introduction of an Italian queen to a very weak colony is useless if European Foulbrood is present. Weak colonies should be united to stronger ones before requeening. If resistant Italian queens are used and the best methods of beekeeping, which ensure strong colonies, are followed there will be little trouble with European Foulbrood. A colony at the beginning of the honey flow should be strong enough to have eight full combs of Langstroth size filled with brood.

Proper wintering of bees is a matter of highest importance in regions where European Foulbrood is found. As very little infection is carried over the winter the first brood of the year usually escapes with little loss. For this reason it is essential to have as much brood as possible get away to a good start early in the spring. The emerging bees are then able to ward off the disease throughout the season.

Where the disease has become well established, it is sometimes difficult for the bees to make headway in cleaning it up. Removal of the queen for a few days causes a period in which no brood is being fed. This gives the bees a chance to make more rapid progress. As soon as the dead larvae are removed, the queen is returned or better still the colony is given a young Italian queen.

How the disease spreads is not thoroughly understood. Honey has a definite devitalizing effect upon the organism so is not a serious carrier. It is never necessary to destroy or disinfect combs, brood, or honey from European Foulbrood colonies. Normally requeening and strengthening the colony will satisfactorily control the disease.

SACBROOD

* Sacbrood is an infectious disease of the brood of bees. Although it is not particularly malignant and rarely, if ever, causes the death of a colony, it is responsible for the loss of much brood. Where the disease is advanced the death of many worker larvae results in the weakening of the colony. Brood rearing space may also be considerably reduced by the presence of dead larvae in the cells.

The disease has never proven very serious in Ontario but it is essential that beekeepers be able to differentiate between it and other brood diseases, especially American Foulbrood.

(a) SYMPTOMS OF SACBROOD

Character of comb and cappings. As in other brood diseases the presence of affected brood, interspersed with healthy brood, gives an irregular appearance to the comb. Larvae die after the cells are capped.

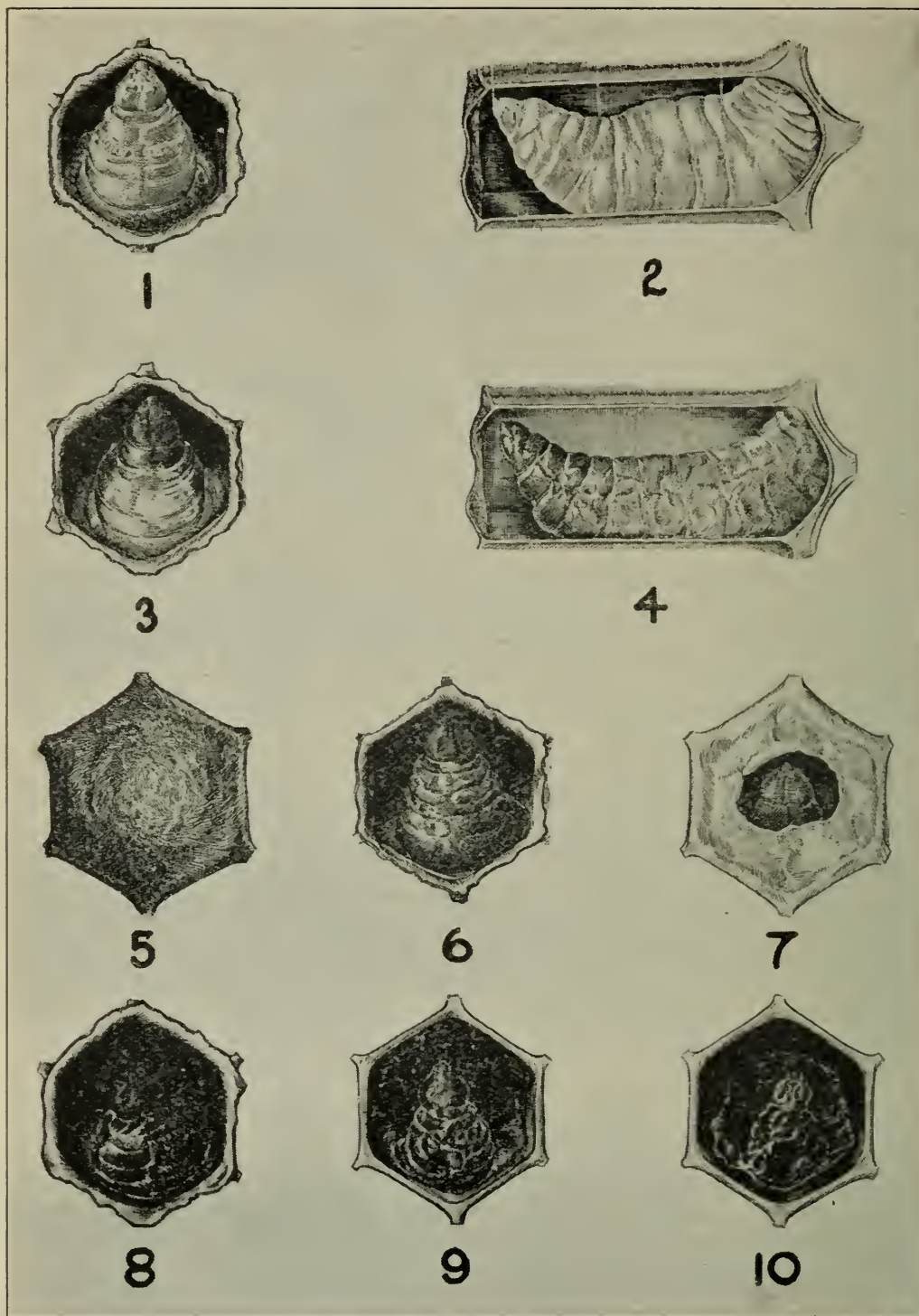


Plate 5.

Sacbrood: 1, 2. Healthy brood at the age at which it dies of Sacbrood; 3, 4. Brood recently dead of disease; 5, 6, 7, 8, 9, 10. Brood in various stages of decay.

—(Reproduced from U.S.D.A. Bulletin 431.)

COMPARISON OF BROOD DISEASES

	A. F. B.	E. F. B.	Sacbrood
Cappings	Many sunken, dark and perforated.	Usually none. When larvae in advanced stages of development, capping, sunken, perforated and greasy.	Many uncapped; some perforated.
Time of Death	During prepupal stage or within two days after transformation to pupa.	Before change to pupa. Generally quite early and before capping. Advanced larval stages often capped.	Before change to pupa. After capping.
Position in the Cell	Straightened out, regular and uniform. Occupies most of lower cell wall. Posterior, or hind end, extending up back wall of cell.	90% of cases curled in the cell and in unnatural positions. 10% in advanced larval stages fairly regular and extended in the cells.	Uniform shape and position in cell with head end curled up.
Colour Changes	From light yellow-brown to dark coffee-brown. Uniform throughout.	From greyish-yellow to dark greyish brown. Not uniform.	From a light yellowish grey to dark brown. Head end darker.
Appearance of Pupa	Same process of decay as larva, tongue extended upwards.	None die.	None die.
Consistency	Soft mass. Exhibits ropiness at certain stage.	Somewhat sticky and granular.	Body wall tough, contents watery.
Tracheae	Not visible.	Often plainly visible.	Not visible.
Odour	Odour of heated glue in advanced stages.	Fishy odour in advanced stages.	No odour.
Scale	Hard, dark, uniform scale. Adheres tightly to cell.	Rubber-like, irregular, shrivelled, dark brown scale. Easily removed.	Black, roughened curled up at anterior or head end.

A considerable proportion of the cappings are uncapped by the bees. As a rule the proportion of brood affected is not large.

Time of death. Affected larvae die after the cells are capped but before the change to the pupal stage is completed. The majority die during the two days prepupal period, i.e. within the two days preceding the transformation. Many uncapped cells are generally observed on diseased combs but they are uncapped by the bees after the death of the larvae.

Position in the cell. Dead larvae are extended lengthwise along the floor of the cell. The position is similar to that of larvae affected with American Foulbrood. Sacbrood, however, can be determined by the appearance of the head which is dark, somewhat shrivelled and turns up towards the roof of the cell.

Colour changes. Soon after death the larval remains are slightly

greyish white in colour. This greyish colour turns to a greyish brown tint which deepens as the process of decay continues. Throughout this period of decay the head end appears somewhat shrunken and much darker than the more posterior, or hind, portion of the body.

Consistency of dead larva. The body wall of a larva dead of Sacbrood becomes toughened and may be easily removed intact from the cell. When removed from the cell the larva is sac-like in appearance. The contents of the sac are watery, containing many fine brown granules.

Odour. Sacbrood has no distinctive odour.

Scale formation. Scales formed from sacbrood are greyish black, roughened and generally curl up at the anterior or head ends. Scales are not common as the bees generally remove the dead larvae before the scale is formed. When present they are loose in the cell.

(b) CAUSE OF SACBROOD

No organism has been found present in dead larvae which can be demonstrated to cause the disease. It has therefore been concluded that the disease is caused by a virus which will pass through the finest of filters. A colony may be inoculated with the disease by feeding syrup or honey containing the virus from dead larvae.

(c) SPREAD OF SACBROOD

Sacbrood virus is readily destroyed. Larvae dead of Sacbrood cease to be infectious after one month. How the disease winters over is not known. Colonies infected in the spring generally recover during the honey flow. The weakening effect of the disease during the spring stays with the colony throughout the honey flow.

(d) CONTROL MEASURES

Vigorous colonies rarely suffer to any extent from Sacbrood. Requeening and strengthening will generally clean up any infection that may occur. It is never necessary to destroy any part of a hive infected with Sacbrood.

FUNGOUS DISEASES

Fungous diseases, although never particularly serious, cause considerable damage in the aggregate loss of bees. There are many types of fungi affecting bees both as brood and adults. Conditions such as the so-called stone brood and chalk brood are typical of the work of fungi. The dead remains become dry and mummified. Molded combs and equipment and mouldy fruits, etc., are believed to cause the infection.

DISEASES OF ADULT BEES

To date there has been no serious trouble from adult bee diseases in any part of Canada or the United States. In England and other parts of Europe they have caused great loss. It is necessary that we know something of the symptoms of these diseases and be ready to stamp out any infestation that might occur.

(a) ISLE OF WIGHT DISEASE

This disease has been a very serious source of loss to British beekeepers. It is caused by a minute mite which crawls into the bee's spiracles choking off its supply of air and possibly secreting a toxine which paralyzes the wing or flight muscles. Most adult bee diseases have quite similar symptoms, making diagnosis from external characteristics difficult.

The following is taken from leaflet No. 253, issued by the Board of Agriculture and Fisheries, 4 Whitehall Place, London, England:

Symptoms:

1. The first symptom noticed is a disinclination to work. They fly about aimlessly and do not gather stores.
2. Later they lose their powers of flight and are unable to travel more than a few yards without alighting.
3. As the disease progresses, the bees are unable to fly more than a few feet, when they drop and crawl. They may be seen crawling up grass stems or other upright objects, but they soon fall down and die. Towards night some may be seen gathered in groups, but they usually die before morning.
4. The abdomen is often swollen.
5. The wings often appear disconnected. Sometimes the legs seem affected, and the bees stagger in their attempt to walk.
6. Finally the whole colony of workers is found clustered in front of the hive, except a few which are found crowded around the queen.
7. The queen and the brood are not attacked, though "chilled brood" often appears subsequently, owing to there being insufficient bees to keep the hive warm.

(b) NOSEMA DISEASE

This disease although fairly widespread is mild in character. It is caused by a protozoan or one celled parasite, *Nosema apis*, which infests the alimentary canal of adult bees. Bees can be infested with *Nosema* spores without showing any marked symptoms of disease, and apparently with little effect on their ability to carry on. Death may result from infection and in the case of excessive infection bring about a weakening effect on the colony through the shortening of the life of the individuals. Bees are often observed crawling around outside the hive or climbing up blades of grass. Requeening and strengthening by giving additional capped brood usually brings relief. Cases of this disease have been known in Canada.

(c) DYSENTERY

Dysentery is more properly a disorder than a disease of adult bees. Bees are only able to void faeces while in flight. During the winter waste matter accumulates in the lower intestine. If the food is of good quality and the bees are not confined to the hives for too long a period, they will be healthy in the spring. If the food contains considerable indigestible material and the bees are unable to fly they often die in great

numbers. In cases of advanced dysentery faeces are voided within the hive and the disorder becomes evident by the resultant spotting.

Material reduction in the adult population is a serious handicap during the spring building-up period. Dysentery can be prevented to a great extent by proper precautionary measures. Bees wintered on good honey or sugar syrup are rarely affected. Poor food, such as honey-dew or honey of high water content, nearly always produces the disorder. Proper winter protection and freedom from disturbances during winter are also factors in the control of dysentery.

(d) PARALYSIS

Very little is known about bee paralysis. It is possible that there are several conditions which result in the so-called paralysis. At any rate beekeepers frequently report that they have observed worker bees crawling in front of the hive with their abdomens trembling. They keep crawling up the side of the hive and up blades of grass and tumbling to the ground. Occasionally individual colonies become rapidly depleted in bees. There is a possibility that the disease may be caused by certain foods.

(e) SPRING DWINDLING

Spring dwindling is the term used to describe the condition when adult bees in a colony die off more rapidly than they are replaced by emerging brood. The condition is brought about by poor wintering and by the colony going into winter with too large a percentage of old, worn-out bees. To prevent this colonies should be supplied with vigorous queens that will continue brood rearing as late as possible in the fall.

SENDING SAMPLES FOR DIAGNOSIS

Brood is frequently found dead in a colony from causes other than infectious disease. We find chilled brood, starved brood and overheated brood. Generally the appearances are characteristic but at times the symptoms may be quite similar to one of the brood diseases. If in doubt a sample of comb, or more preferably a smear consisting of the diseased larva or pupa, folded in a piece of waxed paper, should be sent to the Apiculture Department, Ontario Agricultural College, for examination. Also, if a beekeeper notices adult bees showing symptoms of disease he should send a good number to the Department for examination. Bees that have been dead for some time are not satisfactory for examination. If pieces of comb are sent no honey should be present and the comb should not be crushed.

PESTS OF THE APIARY

(a) THE GREATER OR COMMON WAX MOTH

This is a pest of weak colonies and of stored combs. It is most prevalent in warm climates. The adult moths fly almost entirely at night. The eggs may be laid in masses between the supers or in corners and cracks within the hive. The tiny larvae emerge within a few days and being extremely active soon disperse throughout the hive. In brood combs they burrow along the midrib, out of reach of the bees, spinning a

tough cocoon as they travel. These larvae feed chiefly on pollen, pupal cases and other impurities in the comb. It is thought that very little, if any, wax is digested. When confined to wax and honey as in comb honey infestations, the larvae are unable to develop into the adult stage. Adult moths do no damage to comb.

Combs left exposed act as breeding places for this troublesome pest, and the beekeepers should be careful to keep all combs out of reach of the moth.

When weak colonies are attacked the beekeeper should remove as many of the bee moth larvae as possible as well as the webbing and cocoons. The colony should then be united with a strong colony. Italian bees are more resistant than black bees. Strong colonies are rarely infested. Weak or dead colonies in box hives form excellent breeding grounds for moths.

Various disinfectants can be recommended for the control of wax moth in stored combs:

Sulphur. The amount recommended is 3 pounds per 1000 cu. ft. of storage space, burned for 24 hours in a room made as air-tight as possible. As the sulphur dioxide fumes given off do not destroy the eggs it is necessary to fumigate again two to three weeks later.

Its use incurs considerable fire hazard. Fire Insurance under the Ontario Beekeepers' Association is not available to those who disinfect with sulphur. It is most conveniently used in the form of flowers of sulphur. To use, obtain a large flat pan and place some water in it. Stand the pan in which the sulphur is to burn inside this on two bricks. Place live coals in this pan and put the flowers of sulphur on top. Supers are criss-crossed in piles.

Carbon bisulphide. Is a yellowish oily liquid which gives off a very disagreeable odour. It may be used quite effectively, although the gas does not kill the eggs, and as is the case with sulphur it is necessary to give a second treatment two to three weeks later. The method used is to place two tablespoonfuls or one ounce of the liquid in a small dish and place this *on top* of a stack of five supers. For best results, the cracks between the supers should be closed by means of gum paper, or they may be effectively sealed by moistening strips of newspaper and sticking them around the supers. The stack should remain sealed at least 12 hours. At low temperatures this evaporation is very slow, so it is necessary to have the room fairly warm.

Every precaution should be taken when using this disinfectant, as the gas given off is highly inflammable. When a dish of carbon bisulphide is used on the top super it is necessary to close off the pile by means of an empty super and lid.

Cyanogas. Is a commercial cyanide preparation which is extremely poisonous to humans and animals. Great care should be taken when using it. The gas given off is almost the same weight as air. Cracks in the pile of supers should be closed up and about one tablespoonful of the powder may be placed on a piece of paper somewhere in a pile of five

supers. Be careful not to inhale any of the fumes. It is advisable to do the fumigation outside or in a well ventilated room. Do not tear the supers down for twelve hours. *Do not use cyanogas in a dwelling house—it is extremely poisonous.*

Paradichlorobenzene (P.D.B.) Is one of the most satisfactory insecticides that can be recommended for wax moth control. It is a white crystalline material, with a not unpleasant odour. It is non-injurious to humans at ordinary concentration. It is non-inflammable and very easy to handle.

The gas given off is heavier than air, so a handful of crystals is added on a piece of paper at the top of a stack of five supers. More crystals can be added occasionally throughout the storage period. It is most effective at around 70 degrees F.

Storing Combs. Where much trouble is experienced from mice and wax moth, it is advisable to store the supers of comb in stacks of five with a metal lid or queen excluder at the top and bottom of each pile. One of the various disinfectants should be used and cracks sealed up as far as possible. The most suitable disinfectant recommended for general use is Paradichlorobenzene (P.D.B.). When disinfecting supers, best results are obtained if the stacks are not made more than five supers high. Where the danger of wax moth is not particularly great beekeepers stack the supers up with a sheet of newspaper between each super. Printers' ink apparently acts as a repellant to the wax moth.

Comb Honey. Wax moth larvae can very soon spoil a season's crop of comb honey. Moths will lay their eggs in the cracks between the supers; on hatching the young worms crawl to the comb honey and destroy the wax capping. If trouble with wax moth is expected it is advisable to remove the honey from the colonies as soon as possible. Place 8 to 10 shallow frame supers of honey one on top of the other and use similar fumigation methods as used for stored combs. P.D.B. is particularly recommended for use with comb honey. Some beekeepers use sulphur for this purpose, as the fumes tend to bleach wax, thus making the cappings whiter.

(b) OTHER MOTHS

The larvae of several moths destroy comb. The Mediterranean Flour Moth and Indian Meal Moth larvae sometimes damage comb when burrowing for pollen. The larvae spin silken threads similar to those of the Common Wax Worm, but do not cause as much damage to the comb.

The Lesser Wax Worm does damage similar to the Common Wax Worm, except that the webs are finer and more generally on the surface of the comb. This is not an important pest in Canada, but causes considerable damage in warm climates.

These moths can be controlled by fumigation in the same manner as recommended for the Common Wax Worm.

(c) SKUNKS

Skunks are troublesome in most sections of Ontario. They will scratch in front of a hive to annoy the bees. When the bees rush out they become entangled in the skunk's fur and are rapidly eaten. Skunks also

do much damage in winter by destroying tar paper and exposing hives packed with this material. The control recommended for skunks is to make a small hole in an egg at the air cell end. Then stir one grain of strychnine well into the egg with a tooth pick or small piece of wire. A grain of strychnine is about as big as a pin head. The egg is then half buried near the hive where the skunk can get at it. Every precaution must be taken when using strychnine. Where there is danger of poisoning domestic animals, the egg should be placed under the hive or some place where larger animals cannot get at it. *Persons placing out strychnine in this manner are responsible for any damage that may result to livestock.*

(d) MICE

Bee yards in all parts of the Province are troubled by mice. These pests will destroy comb and build nests alongside the winter cluster in good colonies. The disturbance will generally result in the loss of the colony. They will also build nests in stored super combs during the winter. In some sections chipmunks will do similar damage. Winter entrances should be constructed small enough that mice cannot enter, and piles of supers in storage should be protected both above and below with queen excluders. Poison grains are effective as a means of control. A commercial poison bait known as "Mouse Seed" may be obtained from the Bee Supply Companies, or a mixture of strychnine and grain may be prepared at home. This is done by dissolving 25 grains of strychnine in about 1½ pints of water and placing this in a large container. Completely soak some grain with this liquid. The grain must be dried before using, otherwise it will mold. A small amount of strychnine may also be combined with icing sugar and then mixed with flour or crumbs, or spread on bread.

(e) OTHER PESTS

Pests of lesser importance in Ontario include bears, ants and kingbirds. A stencil sheet of Apiary Pests and their control may be obtained free on request from the Apiculture Department, Ontario Agricultural College, Guelph.

PERMITS TO MOVE OR SELL BEES

All beekeepers are asked to co-operate to the fullest extent with the Apiculture Department in the matter of obtaining permits to move or sell bees.

In the past great losses have been experienced in many sections of the Province, and disease has been introduced into many disease-free areas through the criminal carelessness of certain beekeepers in promiscuously moving diseased colonies or equipment.

The slight inconvenience and possible delay of a sale that sometimes has to occur before a permit can be granted is dwarfed to insignificance by the fact that co-operation in this matter is absolutely essential if disease is ever to be brought under control in the Province.

Persons guilty of moving or selling bees without a permit are subject to a fine of not less than \$50.00 nor more than \$100.00 under the Foulbrood Act. Apiary Inspectors are of the opinion that this section of the Act must be strictly enforced if we are going to hold what we have gained through efficient inspection.

If intending to move or sell bees or equipment write to the Apiculture Department for one or more application forms. These applications to move or sell should be filled out in detail. When the application is received at the Department a permit is sent to your local Inspector. The Inspector in turn issues the permit when he is convinced that the colonies or equipment are free of disease.

When bees or equipment are being sold and moved to a new location only one permit is required to cover sale and removal. This should be procured by the seller.

PRECAUTIONS

- (1) Never buy colonies of bees unless they have been examined by an authorized Inspector and a permit granted by the Department of Apiculture.
- (2) If drawn combs, irrespective of age, are purchased with used apiary supplies, they should be rendered into beeswax, unless positive no American Foulbrood existed in the apiary from which they came.
- (3) Be sure to prevent spring robbing by closing the entrances of all dead colonies early in April, thereby avoiding the spread of disease. The entrances to weak colonies should also be reduced.
- (4) Combs should not be interchanged from one colony to another where there is danger of foulbrood being present.
- (5) Destroy all colonies having American Foulbrood immediately they are found. Make sure your diagnosis is correct before proceeding with the destruction.

If in doubt remove the contents of one or more cells and fold in a piece of waxed or hard finished paper. Place this, with your name and address, in an envelope and forward to the Apiculture Department, Ontario Agricultural College, Guelph, for diagnosis.

- (6) Since honey is one means of transmitting American Foulbrood, it should not be fed to bees unless it is known to be free from Foulbrood spores. When in doubt feed sugar syrup.
- (7) When locating an apiary don't crowd any other beekeeper. Never keep bees in box hives. The control of American Foulbrood is the beekeeper's most important problem. In order to remain in the business and ensure success, constant vigilance must be maintained.

THE BEE DISEASE ACT

Bees are of greater economic importance as pollinators of fruit trees, clovers and other crops than they are as honey gatherers. Because of the very important place of bees in agriculture the Foulbrood Act has been drawn up to safeguard the beekeeping industry. Its purpose is to combat disease and protect the careful beekeeper.

An Act for the Prevention of Diseases Among Bees

(INCLUDING AMENDMENTS WHICH CAME INTO FORCE ON MARCH 31, 1931)

1. This Act may be known as **The Bees Act, 1931.**
- 2.—(1) The Lieutenant-Governor in Council, upon the recommendation of the Minister of Agriculture, may from time to time appoint one or more Inspectors of Apiaries to enforce this Act.
- (2) The Inspector shall, if so required, produce the certificate of his appointment on entering upon any premises in the discharge of his duties.
- (3) The remuneration to be paid to an Inspector under this Act shall be determined by order of the Lieutenant-Governor in Council, and shall be payable out of any sum appropriated by the Legislature for the enforcement of this Act.
- 2a.—(1) Every person keeping bees in the Province of Ontario shall on or before the 30th day of April in every year apply to the Minister of Agriculture in writing, signed by the applicant, for a certificate of registration.
- (2) The application shall be in such form as may be prescribed by the regulations and shall be accompanied by the prescribed fee for registration.
- (3) Every application shall be addressed to the Provincial Apiarist, Ontario Agricultural College, Guelph.
- (4) Where a person commences keeping bees after the 30th day of April in any year, he shall apply for a certificate of registration as hereinbefore provided within ten days after coming into possession of the bees.
- (5) Every person keeping bees who neglects or refuses to comply with the provisions of this section shall incur a penalty of not less than \$5 nor more than \$10 and costs.
- 3.—(1) The Inspector shall, whenever so directed by the Minister, visit any locality in Ontario and examine any apiary to which the Minister directs him, for the purpose of ascertaining if any infectious or contagious disease of bees exists in such apiary.
- (2) If the Inspector finds that foul brood exists in a virulent or malignant type he may immediately destroy by fire all colonies of bees so affected, together with the hives occupied by them and the contents of such hives and all tainted appurtenances that cannot be disinfected.
- (3) Where the Inspector, who shall be the sole judge thereof, finds that an infectious or contagious disease, not being foul brood of a virulent or malignant type, exists among the bees he shall give notice in writing to the beekeeper, instructing him as to the treatment of such disease and stating the time within which such treatment shall be given, and if at the expiration of such time the diseased colonies have not been treated by the beekeeper in accordance with the notice, the same may be treated by the Inspector and the beekeeper shall be liable to the Inspector for all expenses incurred in such treatment.
4. The Inspector may order the owner or possessor of any bees dwelling in box or immovable frame hives to transfer them to movable frame hives within a specified time, and in default the Inspector may destroy or order the destruction of such hives and the bees dwelling therein.
- 4a. For the better prevention of foul brood, the Lieutenant-Governor in Council may, on the recommendation of the Minister, declare a quarantine of bees at any point within the Province and may fix the duration of such quarantine and all other conditions in connection therewith, and any Inspector appointed under this Act shall have full authority to inspect bees in such quarantine when directed so to do by the Minister.
- 5.—(1) The owner or possessor of an apiary shall not sell, barter, give away or

remove from the premises any bees or used apiary appliances or apparatus until he has secured a permit from the Provincial Apiarist that such bees, used apiary appliances or apparatus have been properly disinfected and are free from disease.

- (2) Bees or used apiary appliances or apparatus shall not be imported into Ontario from any other Province in Canada or from any State in the United States of America unless accompanied by a certificate from a provincial or state officer certifying that such bees, used apiary appliances or apparatus are free from any infectious or contagious disease, but this shall not apply to the importation into Ontario of bees apart from combs.
- (3) Every person who contravenes the provisions of subsection 1 or of subsection 2 of this section shall be guilty of an offence and shall incur a penalty of not less than \$50 nor more than \$100.

6. Any person whose bees have been destroyed or treated for foul brood who sells or offers for sale any bees, hives or appurtenances of any kind after such destruction or treatment and before receiving a permit from the Provincial Apiarist so to do, or who exposes in his bee-yard, or elsewhere, any infected comb honey or other infected thing, or conceals the fact that such disease exists among his bees, shall incur a penalty of not less than \$20 or more than \$50, or he may be imprisoned for a term not exceeding two months.

7. Any owner or possessor of bees who refuses to allow the Inspector to freely examine bees, or the premises on which they are kept, or who refuses to destroy the infected bees and appurtenances, or to permit them to be destroyed when so directed by the Inspector, shall, in the complaint of the Inspector, incur a penalty of not less than \$25 and not more than \$50 for the first offence, and not less than \$50 and not more than \$100 for the second and any subsequent offence, and the convicting justice shall, by the conviction, order the said owner or possessor forthwith to carry out the directions of the Inspector.

8. Where such owner or possessor of bees offers resistance to or obstructs the Inspector, a justice of the peace may, upon the complaint of the Inspector, cause a sufficient number of special constables to be sworn in who shall, under the directions of the Inspector, proceed to the premises of such owner or possessor and assist the Inspector to seize all the diseased colonies and infected appurtenances and burn them forthwith, and if necessary the Inspector or constables may arrest the owner or possessor and bring him before a Justice of the Peace to be dealt with according to the provisions of the next preceding section.

9. Before proceeding against any person before a Justice of the Peace, the Inspector shall read over to such person the provisions of this Act or shall cause a copy thereof to be delivered to him.

10. Every owner or possessor of bees, and any other person who is aware of the existence of foul brood either in his own apiary or elsewhere, shall immediately notify the Minister of the existence of such disease, and in default of so doing shall incur a penalty of \$5.

11. Each Inspector shall report to the Minister as to the inspection of any apiary in such form and manner as the Minister may direct, and all reports shall be filed in the Department of Agriculture, and shall be made public as the Minister may direct or upon order of the Assembly.

11a. The Minister of Agriculture, with the approval of the Lieutenant-Governor in Council may make regulations,—

- (a) prescribing the form of application for registration;
- (b) for fixing the fees to be paid for registration and upon a certificate of registration;
- (c) for the registration of beekeepers and prescribing the form of the register and the particulars to be entered therein;
- (d) for requiring beekeepers to make such returns and to furnish such information to the Department as may be deemed necessary or desirable;
- (e) generally for the better carrying out of the provisions of this Act.

12. The Ontario Summary Convictions Act shall apply to all prosecutions for offences against this Act.

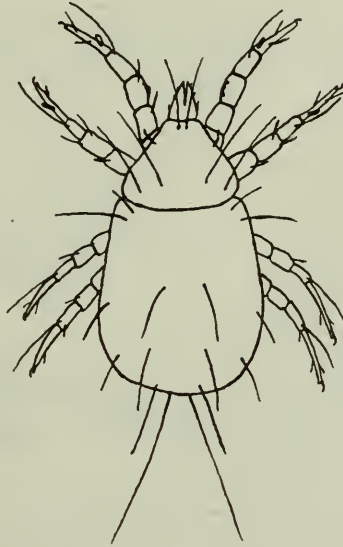
Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

CHEESE MITES AND THEIR CONTROL

G. G. DUSTAN

As cheese mites the last two or three years have been causing a great deal of damage to cheese in curing rooms and warehouses, the writer was asked to make a study of them and their control. The following is a summary of the more important things learned.



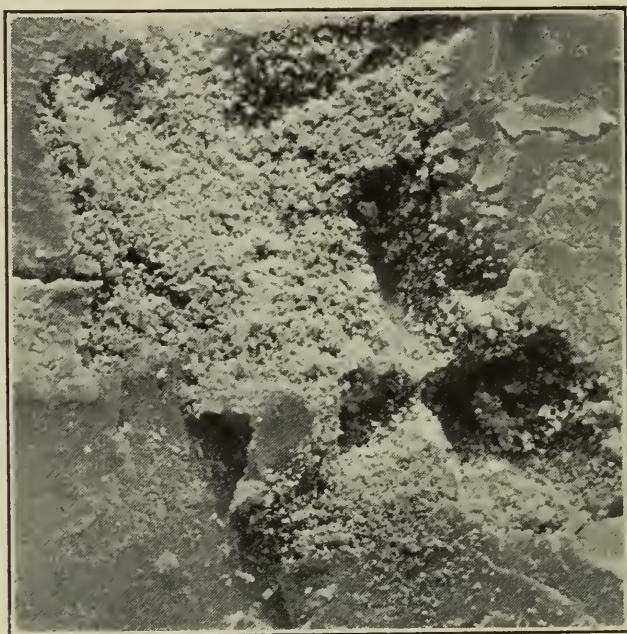
Greatly enlarged drawing of the cheese mite. (Adapted from Banks).

Species Responsible. Several species of mites attack cheese but all look alike and have similar habits. The species involved in this outbreak is *Tyroglyphus farinae* Deg. as determined by Dr. Ewing, Washington, D.C. It is known both as the cheese mite and the grain mite.

Description. The mites are so tiny they are just visible to the naked eye. They are glossy-white and except in the earliest stage have four pairs of legs. The mouth parts are adapted for biting or breaking off and chewing small particles of cheese or other food materials.

Life History. The mites lay eggs wherever they happen to be feeding. These are transparent-white and oval, and under laboratory mean temperatures of about 60° F. hatched in 12 to 14 days. The larvae or nymphs are white like the adults and feed in the same way. They require 3 to 4 weeks to become full-grown. There are several generations a year, and under favorable conditions the mites increase at a surprisingly rapid rate.

Nature of the Injury to Cheese. In feeding the mites find it difficult to get entrance to the cheese itself, if the paraffin covering is intact; hence they nearly always get access at places where the covering is broken or cracked. Even a very tiny crack allows them to enter. They then proceed to feed and in doing so produce a fine pale-brown powder composed of living and dead mites, cast skins, eggs, particles of excreta and of uneaten cheese. It is said a thimbleful of this powder may contain 50,000 mites. The brownish powder on the surface of the cheese affords an easy means of detecting their presence. When feeding in large numbers they not only make holes or pits from one to several inches deep, but also work outwards in all directions under the cover and undermine it. We have seen a 90 lb. cheddar cheese with its entire upper surface covered by the characteristic powder to a depth of $\frac{1}{4}$ to 1 inch. If no treatment is given to control them the mites ultimately reduce the whole cheese to powder.



Injury by mites. Note the conspicuous powder and large pits. The cracks in the cheese were caused by drying and not by mites. (Slightly enlarged).

Method of Distribution. The mites not only feed upon cheese but also upon grain, meal, and many other food materials, wherever these may be. They are present also in at least small numbers in many cheese factories. As a consequence anything brought into the cheese storeroom or curing room from any place infested by mites is liable to introduce them. This is especially so in the case of cheeses from infested factories. Mites may of course be in the warehouse itself on some foods other than cheese and be carried from them to the cheese on the hands or clothing of workmen or on utensils. Moreover they may attach themselves to insects such as house flies and cockroaches and be distributed by them. Once in the cheese room they can readily crawl from one cheese to another.



Badly pitted top of a 90 lb. cheddar cheese injured by mites. The mites and a layer of powder from $\frac{1}{4}$ to 1 inch deep were brushed off before this photo was taken. (Reduced to nearly one-fifth natural size).

Conditions Favoring the Mites. The experience of cheesemen both in Canada and the United States, and tests made by the writer, show that to cheese stored at 32° to 35° F. there is practically no noticeable damage done by the mites. This is because they are dormant or nearly dormant at these temperatures. From 35° to 40° F. there is some development but it is slow and usually cheese can be stored at these temperatures for several months with comparative safety. Above 40° the mites become more active and injurious and at 50° to 60° F. they are very active and do great damage. There is little doubt that the main cause of the increased injury of the last two or three years can be attributed to the higher temperatures used in curing rooms to hasten the ripening of the cheese. High humidity also favors the mites but not to so great an extent as high temperatures. Another favoring factor is dirty, unsanitary conditions such as greasy shelves, accumulation of parings and other cheese waste.

CONTROL. (1) **Low temperatures.** The best method and the one most commonly practised, is to keep the curing room and storeroom at a temperature of 32° to 35° F. and not higher than 40° F. Since new cheese is seldom attacked for a week or ten days it would probably be safe, if the owner wished to hasten the curing a little, to hold it at a temperature of 50° F. or slightly higher for that period and then lower it to 32° to 35° F. for the remainder of the time. (2) **Fumigation.** This is the only other control that the writer has found satisfactory, and the only one by which the cheese and premises can be quickly rid of these pests without injuring the former. If the higher temperatures are used to cure the cheese more rapidly, fumigation seems to be the only effective means of control, if mites are present.

Requisites of a Good Fumigant for Cheese. A good fumigant should possess the following characteristics: (a) It must kill all stages of the mites including the eggs, not only in the cheese itself, but all through the room. (b) It must not be inflammable. (c) It must not taint, nor stain, nor affect the texture of the cheese, nor leave any injurious residue. (d) The gas or odor should be easy to remove from the building after the fumigation is finished. (e) The cost should not be prohibitive.

Unsatisfactory and Satisfactory Fumigants. The above characteristics, in the writer's opinion, exclude such well-known and common fumigants as hydrocyanic acid gas and chloropicrin, and any combinations containing either of these, also carbon bisulphide and any of its combinations, sulphur dioxide, ammonia, formaldehyde, naphthalene, and paradichlorobenzene.

Of the fumigants tested only two were found satisfactory: (a) Methyl bromide 6.8% plus carbon dioxide 93.2%*, and (b) Ethylene oxide 1 part plus carbon dioxide 9 parts‡. There are probably others that are also satisfactory but they have not come to our attention and so have not been tested. The methyl bromide-carbon dioxide mixture is sold in 20 and 50 lb. cylinders, costs 20c per lb. and 20 lbs. are required for every 1,000 cu. ft. of space. The ethylene oxide-carbon dioxide mixture is sold in 30 and 50 lb. cylinders, costs 23c per lb. and 20 lbs. of it too are required for every 1,000 cu. ft. of space. Full directions for the use of these may be secured from the manufacturers. Neither of these gases has an irritating or very offensive odor.

Precautions in Fumigation. (1) The fumigation chamber must be air-tight, otherwise a satisfactory kill is not likely to be obtained. In most cases it is not necessary to build a new chamber; for the storage or curing room can usually be overhauled without great expense. But before it is used it is necessary to test it with a smoke smudge for leaks. The cheese would have to be removed before this is done or the smoke would, we think, taint the cheese. The room should also be equipped for the use of an electric light and for a fan, and the switch for these should be placed outside the room where it can be turned on or off without having to enter. It should be so installed that there can be no short-circuiting. (2) Fumigation should never be done when there is any person working or present in the building; hence Saturday noon or evening, when the building has been vacated, is a good time to begin it. (3) It should always be kept in mind that any good fumigant when concentrated is likely to be toxic to humans; so no one should enter the chamber while fumigation is in progress nor afterwards until the gas has practically all escaped. Moreover for greater safety two men should always be assigned to the work. (4) No matter what fumigant is used the manufacturer's directions for liberating the material into the chamber should be closely followed, and then the door locked and a warning sign put on it,— "**Fumigation—DANGER—Keep Out.**" (5) When 24 hours

* This mixture was purchased from the Liquid Carbonic Canadian Corporation Limited, Toronto.

‡ This mixture was purchased from the Dominion Oxygen Company, Toronto.

have elapsed all windows and doors nearby should be opened to create a draft, and then the chamber door itself and any other outlet for the gas opened wide and the fan turned on. As soon as this is done, the operators should withdraw for at least an hour, by which time practically all the gas will have disappeared and it will be safe to enter to close the windows and doors. The chamber door, however, and any other outlet in the chamber, should be left open until the next morning. (6) The temperature at which the writer fumigated was around 60° F. and at this perfect control was obtained in all cases. The chamber of course was air-tight. At temperatures of 65° to 70° there is some danger of softening the cheese. (7) We fumigated cheeses without removing them from their boxes or taking off the lids and got perfect control, but we are not sure that this would always be so, if the boxes were tight and were piled one on another. Removing the covers of the boxes would make more certain of a complete kill. (8) No cheese should be eaten after being fumigated until 3 or 4 days have elapsed. This is to allow any gas in it to escape.

Tests for Undesirable or Toxic Residue. In the case of the ethylene oxide-carbon dioxide mixture the cheese was tested by four persons and found to be unaffected in odor and flavor. No tests for toxic residue were made because this material had been studied by the Washington authorities* and pronounced harmless to food materials.

Cheese fumigated by the methyl bromide-carbon dioxide mixture was eaten by at least six persons and it was found that in no case where the paraffin coating was present during fumigation could any foreign flavor be detected, but where the paraffin had been cut away by the writer just before fumigation, there was an unpleasant flavor. This extended from the surface into the cheese about $\frac{1}{2}$ inch. This foreign flavor, however, completely disappeared in 3 to 4 days.

The following tests were made to determine whether any harmful effects might follow from eating cheese and certain other foods fumigated for 24 hours with the methyl bromide-carbon dioxide mixture at the rate of 20 lbs. per 1,000 cu. ft. In each of these tests the food was exposed to the air for 24 hours after coming from the fumigation chamber and each animal was starved for 24 hours before being fed the treated foods. The animals received fresh water daily:—(a) A cat was fed 3 pints of milk which had been fumigated in an open pan. It drank the milk readily, consuming it all within $2\frac{1}{2}$ days. (b) Two white mice were fed fumigated cheese and unfumigated rolled oats for a period of 3 weeks, and consumed about $\frac{1}{4}$ lb. of the cheese. (c) Two white mice were fed fumigated rolled-oats and unfumigated cheese for 3 weeks and consumed about $\frac{1}{4}$ lb. of the former. (d) Two white mice were fed on a mash made of fumigated milk and unfumigated rolled-oats for 1 week, followed by unfumigated rolled-oats for 2 weeks. (e) Two guinea pigs were fed 2 large mangolds and 6 medium-sized carrots. One of the mangolds and 3 of the carrots were cut in half before being fumigated, the others left whole. They consumed all of these in 3 weeks. (f) Two hens consumed in a period of 1 month 12 lbs. of fumigated crushed oats.

* U.S.D.A. Circ. 369, p. 32, 1935.

None of the animals showed any aversion to the food, nor did they act at all abnormally during the experiment, and at the time of writing, 6 weeks later, all appear to be normal and healthy.

From the above tests and the experience of some of the American experimental stations we believe that the methyl bromide-carbon dioxide mixture may safely be recommended for the fumigation of cheese but, as mentioned above, it would be wise not to use such cheese until four days have elapsed and any flavor present has disappeared.

The Importance of Sanitary Conditions in the Curing and Store-rooms. When curing rooms or storerooms are either free from mites or very lightly infested a good deal can be done to prevent serious loss by attention to sanitary measures:—No grease should be allowed to accumulate on the shelves or elsewhere. No cheese parings or other cheese waste should be allowed to remain in the room, but should be taken out and burned. The floors, walls, shelves, and any other structures, wherever practicable, should be thoroughly gone over, whenever it seems desirable, with very hot water or with live steam. In doing so it will be necessary to hold the nozzle of the hose within a foot of the part being treated, otherwise the temperature will be lowered by the air too much to kill the mites. A wash of formalin diluted 1-6 will kill many mites and also keep down mould. In addition to the above all cheese should be examined at the time it is brought in, and also once at least every month afterwards, to see if any of the characteristic brown dust, indicative of mites, is present. If a cheese is only lightly infested the dust should be scraped off into a vessel and burned, but if severely injured the whole infested area should be cut off and burned and the cut surface paraffined.

Summary. Cheese mites do little damage at temperatures of 32° to 35° F. At temperatures between 35° to 40° F. they increase slowly. At temperatures over 40° F. and especially above 50° F., they increase rapidly. The best control is storage at 32° to 35° F. At temperatures above 40° the only satisfactory control is by fumigation. Methyl bromide-carbon dioxide, and ethylene oxide-carbon dioxide are satisfactory fumigating materials when used in an air-tight chamber. Sanitary measures help to prevent infestation or to lessen the degree of it.

Acknowledgements. The writer wishes to thank Professor Caesar for suggestions and helpful criticism throughout the work, and to express his indebtedness to the Departments of Dairy, Horticulture, and Field Husbandry for kindly providing cheese and facilities for fumigation and cold storage experiments.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

GUELPH, ONTARIO

DISEASES OF VEGETABLES

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INTRODUCTION

The object of this bulletin is to furnish all who are interested in the growing of vegetables with information which will enable them to identify the more common diseases of vegetables, and to apply intelligently the treatments which experience has proved to be the most effective in each case.

In a bulletin of this nature it has been thought wise to include the bacterial with the fungus and virus diseases, in order to place in the hands of the grower a complete and convenient manual of all the more important diseases of vegetables.

The majority of the diseases of vegetables are what are known as fungus, bacterial and virus diseases. It is important that those having to deal with them should understand fully the cause of such diseases in order that they may apply intelligently remedies for their control.

THE NATURE OF FUNGUS DISEASES

Fungus diseases are caused by plants known as fungi. These plants, unlike ordinary flowering plants, have no green coloring matter (chlorophyll) and are unable, therefore, to manufacture their own food. All their nourishment must be obtained from living plants or animals or the remains of them. Those fungi which derive their nourishment from living plants injure them in various ways, and thus give rise to what are known as fungus diseases.

The bodies of fungi which cause plant diseases are usually extremely small and very simple. They consist of very fine, delicate, thread-like structures (hyphae), some of which become modified and produce reproductive bodies called spores. The spores may be considered similar to the seeds of flowering plants. Sometimes the fungus threads live upon the surface of the plants and obtain their nourishment by sending little suckers (haustoria) into the cells of the plant below. Most frequently, however, they live within the plants, either in, or between the cells. Two kinds of spores are usually produced (1) thin-walled summer spores, which spread the disease during the growing season, and (2) thick-walled resting or winter spores, which serve to carry the disease over the winter. Spores

are scattered by various agencies, such as wind, water and insects. When they come in contact with a suitable host plant, they send out little threads (germ tubes) which enter the plants through the little pores on the leaves (stomata), through the skin or through wounds. Once within the plant, these little threads grow rapidly, drawing their nourishment from the cells of the host plant and set up a diseased condition.

Generally speaking, in combating fungus diseases only methods of prevention are practicable, as once a fungus is within the plant nothing can be done to destroy it. Care should be taken to keep the crops in a healthy growing condition and free from injury by insects. Unthrifty plants and those attacked by insects are more subject to fungus diseases than healthy ones. Rotation of crops should be practised, so that the winter spores left in the soil may not infect the next season's crop. Weeds should be destroyed, as they frequently harbor fungi. Diseased crop refuse should be burned and not thrown on the manure heap. Fresh manure should be avoided, as it frequently contains living spores of parasitic fungi.

Intelligent and thorough spraying with Bordeaux or other fungicides will do much to prevent the spread of fungus diseases. It should be kept in mind, however, that spraying is done not to cure, but to prevent disease. In other words, the object of spraying is to cover the surface of the leaves, fruits or other parts of the plant with a substance which is poisonous to the spores of fungi, and in which they cannot grow and penetrate the plant. Spraying, therefore, in order to be effective, must be timely and thorough. The spray mixture must be on the plant before the spores reach it, and the surface of the leaves, fruit and other parts of the plant must be covered so completely that there is not the smallest space on which a spore can germinate.

THE NATURE OF BACTERIAL DISEASES

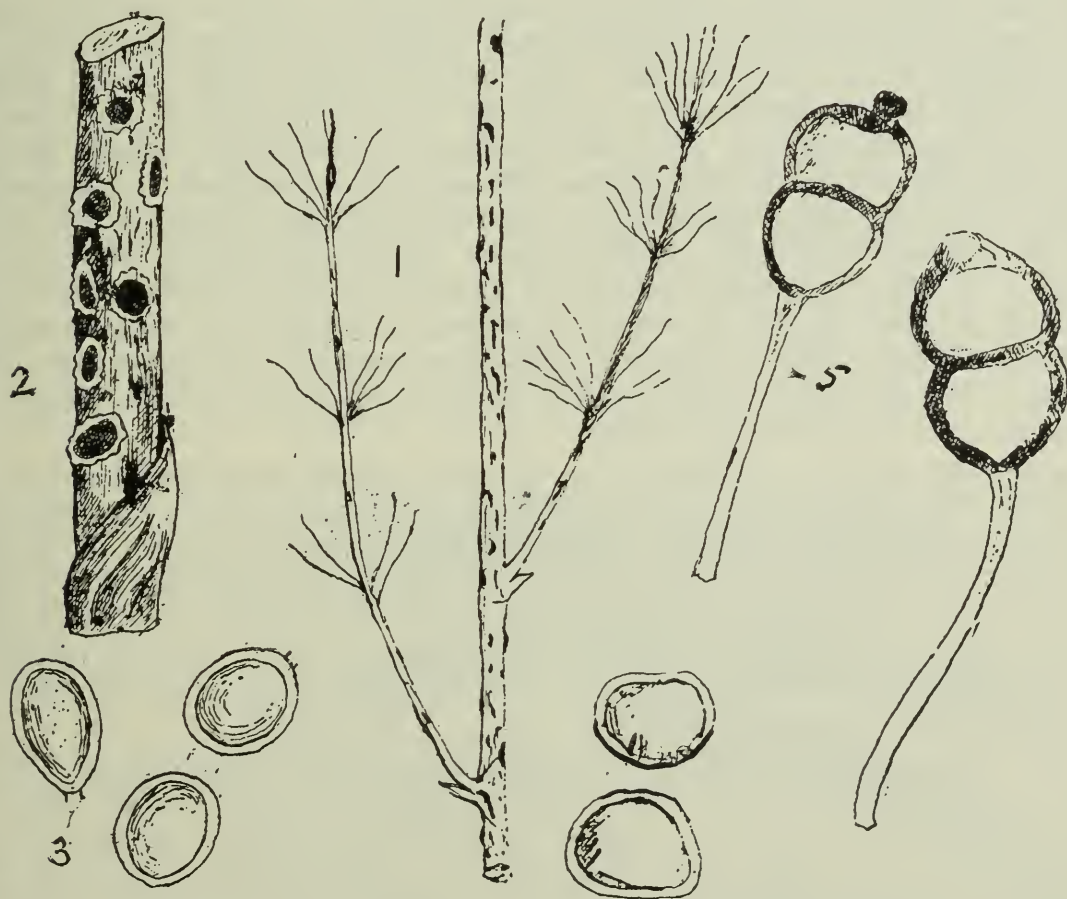
These are caused by bacteria which are single celled minute plants, visible only by the highest magnification of the microscope. In size they vary considerably, but if 25,000 average sized organisms were laid side by side they would measure approximately one inch. They are so simple in structure that all the vital functions such as reproduction, respiration and movement take place within each single cell. They multiply by simply laying down a partition across the cell, and on each side of the partition a new cell is formed from the old half, giving two new daughter cells. This process may take place about every 20 minutes under favourable conditions, and one bacterium may give rise to ten millions or more in 24 hours. They are unlike the higher plants in that they do not possess any green colouring matter (chlorophyll), and for this reason cannot manufacture their own food. Since they cannot manufacture their own food they must live either on dead or decaying organic matter, in which case they are called saprophytes, or on other forms of life such as plants, animals, insects, humans, etc., when they are called parasites. Fortunately most of the thousands of species of bacteria live on dead material and render great service by breaking it down to simple substances which are used by plants as food.

In this bulletin, however, we are dealing only with those forms which live in plants, and of course they must derive their food supply from the plant sap. In this way they cause varying degrees of injury such as leaf spots, blights, wilts, soft rots, and in some instances death of the plant. Their method of entry into the plant varies, and this is discussed in connection with each disease. These bacteria live over on or in the seed, in the soil, in cankers of woody plants and sometimes in the bodies of insects.

They are dispersed by wind, water, insects, on seed, and by the hands and implements of workmen. They enter the plant chiefly through breathing pores (stomata) and wounds made by insects and cultivation.

THE NATURE OF VIRUS DISEASES

These are diseases that are not caused by any fungus, bacterium or any organism that can be seen with a microscope. It is believed that they are caused by a living "something" in the juice of a diseased plant which, for want of a better name, is termed a virus and which, if transferred under certain conditions to a healthy plant, will cause the disease. In many instances the virus may be spread from diseased to healthy plants in any manner that the juice may be carried from one plant to another. Thus many of these virus diseases may be spread from plant to plant on implements, pruning knives and on the hands of workmen. Examples of diseases that may be spread in this way are Cucumber Mosaic, Tomato Mosaic and Tobacco Mosaic. The virus of many of these diseases is spread from diseased to healthy plants by insects. Plant lice or aphids are the chief carriers, though some viruses are spread by other insects. Some of these viruses are carried over from season to season in the seed. This is true of the virus causing Bean and Lettuce Mosaic. Many of these viruses infect a great many kinds of plants belonging to different families, thus the problem of control is greatly complicated.



4
ASPARAGUS RUST

1. Attacked stem showing spore clusters.
2. Cluster-cup form.
3. Spores from cluster-cup.
4. Spores from summer stage (urediniospores).
5. Resting or winter spores (teliospores).

ASPARAGUS RUST

This disease is often seen in Ontario. Before the advent of varieties of asparagus resistant to rust it frequently caused severe injury to asparagus in many parts of the Province.

Symptoms—There are three distinct stages of this disease. The first is known as the cluster-cup stage or the spring form. It appears on the young shoots shortly after they come above the ground. On these are seen orange-yellow or greenish yellow cup-shaped pustules grouped in oval clusters. This stage of the rust is seldom noticed by asparagus growers. The second or summer stage is the one that is usually first noticed and is called by them the red rust on account of the elongated reddish-brown pustules which are seen breaking through the skin on the stem. The third stage of the disease is seen towards fall or whenever the vitality of the asparagus plants is reduced. It is known as the black rust or winter rust and is characterized by elongated black lines which replace the reddish-brown pustules of the red rust stage.

Cause—The fungus which causes asparagus rust is *Puccinia asparagi* D.C. It produces four kinds of spores which take a direct part in its life history. In the elongated black lines of the black rust or winter rust, thick-walled two-celled dark brown spores are produced. These are known as winter spores (teliospores). They pass the winter on the old asparagus tops and refuse. In the spring they germinate, and each one may produce eight very minute spores which we may call spring spores (basidiospores). These are scattered by the wind about the time the young asparagus shoots are emerging from the ground. They infect these young shoots and give rise to the cluster-cup stage of rust. In each of the cup-shaped pustules on the young shoots are produced chains of thin-walled orange-coloured spores known as cluster-cup spores. These cluster-cup spores are scattered by the wind and infect the stems of asparagus plants giving rise to the red rust or summer rust stage of the disease. In the elongated reddish-brown pustules of this stage are produced numerous thin-walled oval orange-coloured spores known as red rust spores or summer spores (urediniospores). These serve to spread the rust during the growing season. Moisture is essential for the spread of the rust, heavy dews having more influence on its spread than rain.

Control—Grow varieties of asparagus which are known to be rust resistant. Martha Washington and Mary Washington are two commercial varieties which are resistant to rust. If a grower desires to secure a resistant variety of asparagus and is not sure where to obtain it, he should consult the agricultural representative in his county, or the Department of Horticulture, Ontario Agricultural College. The various gardeners' journals print advertisements of reliable firms that sell desirable rust resistant strains of asparagus.

It is very difficult indeed to prevent rust from developing on varieties which are susceptible to it. Such varieties should be put as far away from all windbreaks as possible. The rows should be planted in the direction of prevailing winds and far enough apart to permit air to circulate freely among the branches so that the excessive moisture on the plants from dew and rain will dry up quickly. Do not let any plants, even wild ones, mature during the cutting season. Late in the fall when growth is over cut out and burn the old plants. Destroy any wild asparagus plants that may be growing in the neighbourhood of the asparagus bed. Spraying with Bordeaux mixture and dusting with sulphur have been tried and fair results obtained in the United States. Spraying or dusting, however, is a difficult

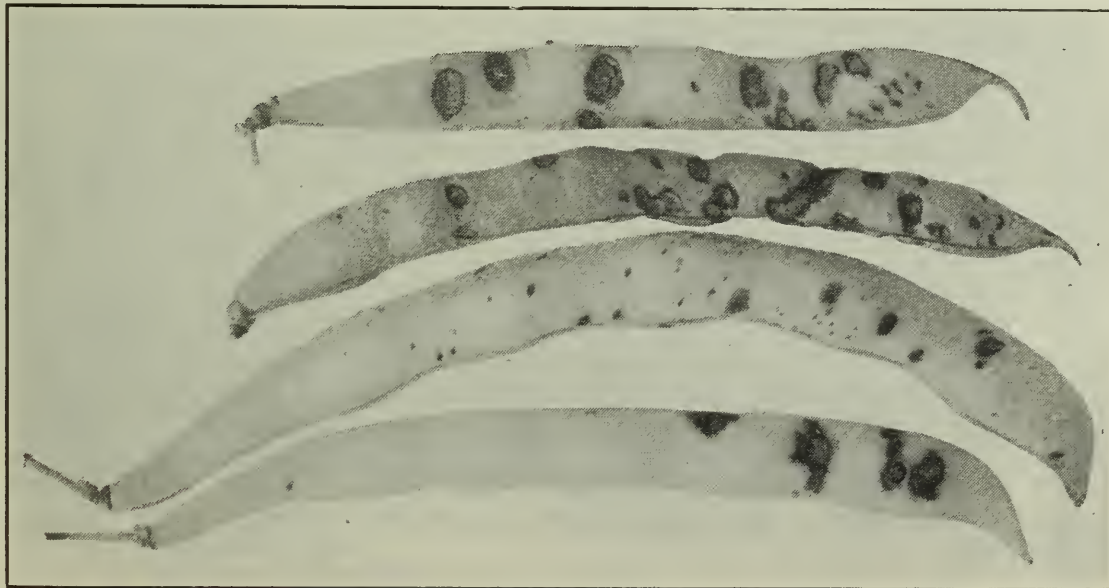
and costly undertaking and it is doubtful whether it would pay here in Ontario.

BEANS

Anthracnose or Pod Spot—This is the most common and most serious disease to which beans are subject. In wet seasons it causes great loss by destroying both garden and field beans.

Symptoms—Pods, seeds, leaves and stems are affected. On the pods sunken, reddish-brown or black spots, usually with rusty brown borders, are seen. In the centre of these spots a pinkish coloring may be noticed frequently. Affected seeds show dark brown or rusty discoloured spots. These are often very minute. On the leaves the chief symptom is the brown and rusted appearance of the main veins underneath. Sometimes these appear as if cut or eaten out by the fungus. Occasionally small holes appear in the leaf. These are due to the destruction of the smaller veins by the fungus. On the stems, rusty brown, elongated spots are sometimes seen. Occasionally these spots are so deep as to cause the stem of the leaf to break at this point.

Cause—This disease is caused by the fungus *Colletotrichum lindemuthianum* (Sacc. & Magn.) Bri. & Cav. This fungus passes the winter chiefly as dormant fungus threads (mycelium) in infected seed and possibly to some extent as spores on the seed. It is also known to winter over on diseased plant refuse left in the field and in beanstraw. This fungus, however, does not live long in the soil when separated from its host. The seed can be infected only through the pod, that is, the fungus threads (mycelium) penetrate through the tissues of the pod into the seed beneath so that pods that are spotted with anthracnose contain infected seed while those that are free from spots contain non-infected seed. When infected seed is sown in the spring the fungus threads inside become active and grow, and the first crop of spores of the season is produced on the seed leaves (cotyledons) of the seedlings. From these they spread to the true leaves and stems and later to the developing pods. The spores of this fungus are held together on the surface of the affected parts by the gelatinous nature of the spore-coat, and are only scattered when the beans are wet with rain or dew which dissolves the gelatinous substance by which the spores are glued to the surface of the pod.



Bean Anthracnose Pods, showing the spots characteristic of the disease.
(Courtesy of the Department of Plant Pathology, Cornell University.)

Control—Use non-infected seed. Such seed can be secured by selecting it from disease free pods. This method is simple and satisfactory for small garden plots of beans and for a seed plot from which to secure the seed supply of field beans for the following year. In the fall of the year after the beans ripen, gather enough disease free pods to supply the seed necessary for the following season. Clean seed alone, however, is not enough to insure a healthy crop. It must be planted far enough away from other bean fields so that the spores will not be carried from the diseased plants to the healthy plants grown from clean seed. If Anthracnose is bad beans should not be planted on the same ground oftener than once in three or four years. Beanstraw should never be used for manure with the bean crop. It is not advisable to work among beans when they are wet with rain or dew as the spores of the fungus which causes the disease are easily scattered at this time. Some varieties of beans are much more resistant to Pod Spot than others. These varieties of beans can be used to advantage. Robust Pea Bean, Wells Red Kidney, Perry Marrow, The York, The Geneva and the New Nova Scotia Marrow are varieties of dry beans which show a marked resistance to Pod Spot. There are a number of varieties of wax and green pod, bush and pole beans which are more or less resistant. Burpee's stringless green pod has shown marked resistance in field trials here at Guelph.

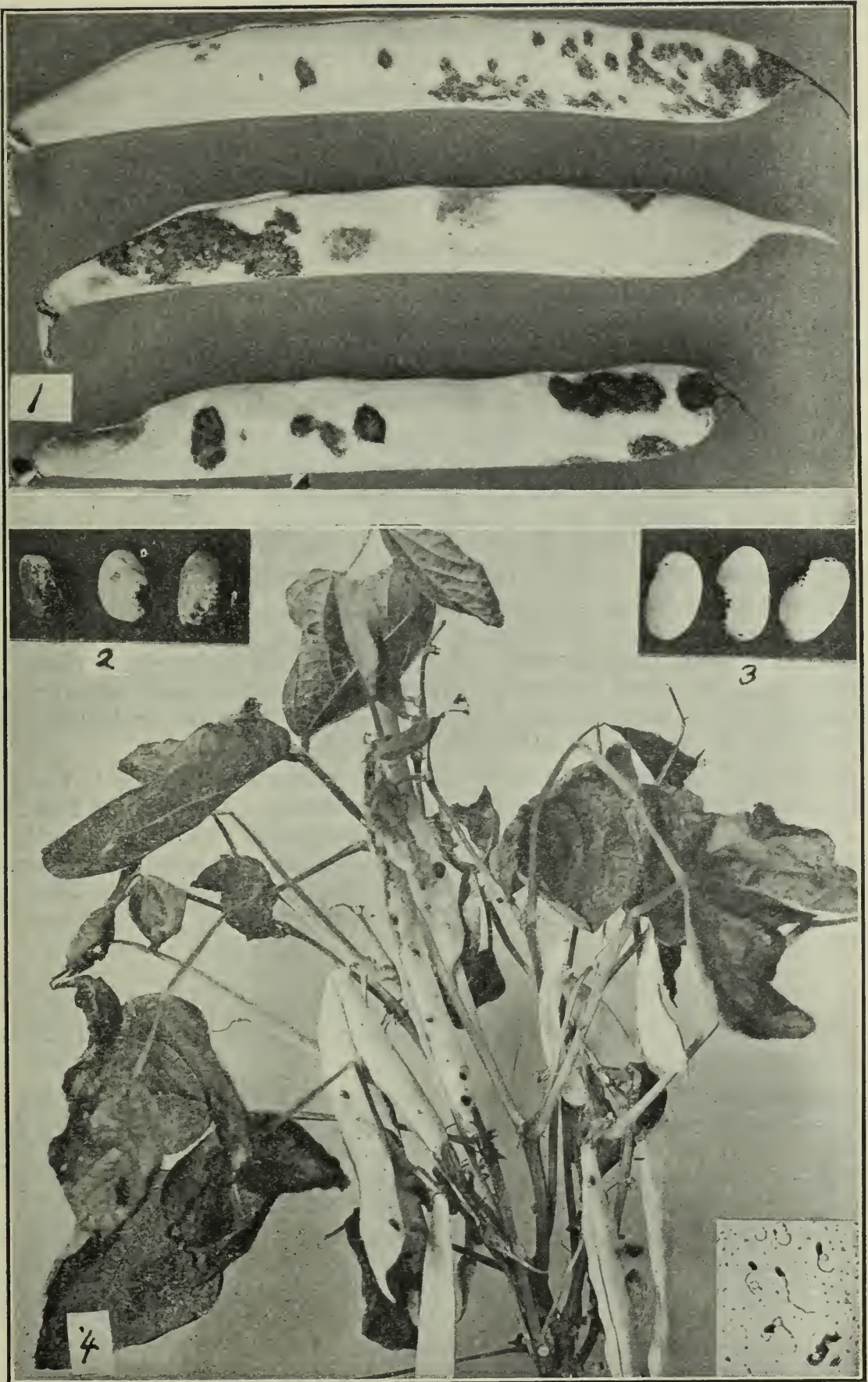
BEAN BLIGHT OR BACTERIOSIS OF BEANS

This is the most serious bacterial disease of the bean in Ontario.

Symptoms—This disease is characterized by a marked spotting of the leaves, stems, pods and seeds within the pods. Wilting occurs when the veins of the plant are invaded. On the leaves, spots appear around the point of infection as "water-soaked" dark green or translucent areas which enlarge and form irregular blotches, yellowish to brownish in colour. These areas may coalesce and rupture so that the leaves take on a ragged appearance. When the plants are succulent a light amber coloured sticky fluid oozes from the diseased parts and later dries to form a thin shiny scale on the surface. On the stems and leaf petioles, "water-soaked" areas appear at points of infection; these may extend lengthwise or they may girdle the stem. Later they become dry and brittle, and this results in breaking of the stems and defoliation of the plant. On the pods, water-soaked spots develop into enlarged reddish-brown blister-like cankers, which are often slightly raised above the normal surrounding tissue. Frequently the seeds within the pods become infected from the diseased spots on the pod. If such occurs when the seeds are young they fail to mature and become shrunken and discoloured. If the seeds are nearly mature before they are affected they become covered with the sticky varnish-like coating, consisting of a large number of the disease producing bacteria; these bacteria may remain alive for several years in this state. For this reason seed from diseased plants should not be sown. Sometimes the cotyledons or seed leaves become infected, and in such instances the veins (vascular system) of the young plant become plugged with the bacteria; this results in wilting and death of the plant.

This disease can be differentiated from Anthracnose or Pod Spot of beans by comparing the symptoms described above with those of Anthracnose.

Cause—This disease is caused by *Phytomonas phaseoli* (E. F. Smith) Bergey et al. These bacteria gain entrance to the various parts of the



BACTERIOSIS OF BEANS

1. Diseased pods.
2. Diseased beans from diseased pods.
3. Healthy beans.
4. Bean plant badly affected with bacteriosis in foliage and pods.
5. *Ps. phaseoli*, the cause of the disease.

plant through the breathing pores (stomata), or through wounds made by insects, cultivators, etc. On gaining entrance, the bacteria feed on the plant juices and multiply rapidly.

Control—Whenever possible, seed should be selected from fields free from this disease. Bean straw should not be used as manure on fields where beans are to be grown, and as long a rotation of crops as practicable should be followed. It should be remembered that infected seeds will produce infected plants, even when such seeds have been kept for years.

BEAN MOSAIC

This disease is common in Ontario. It sometimes causes very serious loss especially to pea beans. Certain strains of pea beans have had to be discarded on account of their susceptibility to this trouble. Wax beans and green pod bush beans are also subject to Mosaic.

Symptoms—Badly affected plants are stunted and sickly yellow in colour with the leaves puckered and mottled with an alternate light greenish-yellow and dark green patches. The diseased plants usually remain alive until the end of the season. Those which are infected early in the summer rarely bear any seed though they sometimes continue to blossom until autumn. Those that do not contract the disease until late in the summer develop pods which are apparently normal.

Cause—Bean Mosaic is caused by a virus which is carried over the winter in the bean seed and possibly also in white sweet clover plants. In the field the bean mosaic virus is spread chiefly by various plant lice (aphids), and to some extent by mechanical means, such as wind and cultivators. It has been shown that it spreads much faster on beans grown close to fields of clover and alfalfa.

Control—The use of the more resistant varieties of beans is the most practical method of avoiding loss from Bean Mosaic. The Robust Pea Bean is a field bean immune or nearly so to this disease. *Other varieties of beans which are resistant in various degrees to Mosaic are: Red Marrow, White Marrow, Long Pod, Keeney Rustless, German Black Wax, Michigan White Wax, Refugee Wax, Prolific Black Wax, Scarlet Flagolet and Red Valentine.

BEAN RUST

This is seldom a serious disease in Ontario. It is seen on all kinds of beans, especially pea beans.

Symptoms—Rust spots appear on all parts of the plant above the ground. They are, however, usually most numerous on the under side of the leaves. The rust spots are distinctly circular, slightly raised. At first they are reddish-brown in colour, later in the season they turn black. They may be very numerous on the under surface of the leaves.

Cause—The fungus which causes bean rust is *Uromyces appendiculatus* (Pers.) Lev. This fungus produces red rust spores (urediniospores) and black rust spores (teliospores) on the lower surface of the leaves and other affected parts of the plant. It is carried over the winter chiefly as the teliospores on the old leaves and stems.

Control—The easiest way of avoiding this disease is by using the more resistant varieties. Pole Beans are more susceptible to rust than are bush varieties. Green Pod strains are less resistant than wax pod ones. Nothing has been done in Ontario in the selection of resistant varieties

*Manual of Vegetable Garden Diseases by Charles Chupp.

as bean rust has never been a serious disease in this Province. Experimental work carried on in Virginia has supplied us with the following lists of more or less resistant varieties:

Resistant varieties of pole beans: Marblehead, Tennessee Wonder, Brockton, Indian Chief, Everbearing.

Resistant varieties of bush beans: Hodson Green Pod, Early Refugee, Mexican Red, Golden Eye, Detroit, Hodson Wax, Wells Red Kidney, White Kidney, Yellow Eye.



Leaf of beet attacked by leaf-spot fungus
(*Cercospora beticola* Sacc.)

BEETS

Leaf Spot—This disease is very common in Ontario but seldom causes serious injury to garden varieties. In some seasons it severely injures the leaves of sugar beets and mangels.

Symptoms—It is easily recognized by the small white or brown spots with purple margins which are scattered irregularly over the leaves. In the later stages of the disease these spots become ash-grey in colour. When they are very numerous the leaves wither and die. Sugar beets severely injured by this disease develop long crowns and are not desirable for sugar purposes.

Cause—This disease is caused by the fungus *Cercospora beticola* Sacc. The spores of this fungus are scattered by rain, insects, cultivating tools, workmen and wind. It passes the winter in the old infested refuse or on the seed. High humidity and temperature increase infection by this fungus.

Control—Plow under the old leaves deeply in the fall. Do not grow beets or closely related plants (mangels and Swiss chard) on the same

ground oftener than once in two or three years. In small gardens rake up the diseased leaves and burn them or feed them to cattle. If the leaves of sugar beets or mangels are harvested and placed in the silo the fermentation will destroy the fungus. Spraying with Bordeaux every two weeks or ten days will control this disease but is seldom necessary.

CABBAGES

Club Root—This is a disease of cabbage, cauliflower, turnips, radishes and other members of the mustard family (Cruciferae). It is a very troublesome disease in the Maritime Provinces, and is occasionally found in Ontario, especially in market gardens in the vicinities of our larger cities.

Symptoms—Affected plants are noticed to flag or wilt markedly and if their roots are examined irregular thickenings and knob-like swellings are found upon them. These often reach the size of a man's fist. The tops of diseased plants develop very slowly. Affected cabbage and cauliflower plants form little or no head. Sometimes the plants are completely killed. Late in the season the diseased roots may rot.

Cause—This disease is caused by a slime fungus known as *Plasmiodiophora brassicae* Wor. This is a soil organism that may remain in the soil for several years. It is spread in seedling plants, in contaminated manure, on farm implements and on the feet of man and animals. It may be washed from high to low land by running water. Experiments have shown that this parasite does not thrive in soil which is highly alkaline and that it does most damage in poorly drained acid soil. It is stated that the spores germinate and infection takes place readily only when the soil is warm and wet.

Control—The choice of well drained soil, the destruction of weeds belonging to the mustard family, the practice of long rotation of crops and the necessary precautions to prevent the planting of infected cabbage and cauliflower seedlings are very important measures in the prevention of this disease. The location of the seed bed is important. (It should be so situated that it is not subject to being washed by water running down from higher ground above it.) The position of the seed bed should be changed from time to time or the soil in it renewed or sterilized with steam. Seedlings should be carefully inspected for any evidence of Club Root. If any infected seedlings are discovered all of them should be discarded as many of them will probably develop the disease if they are planted out. If seedlings must be grown in infested soil, corrosive sublimate should be used to disinfect the soil about the roots of the seedling plants. It has been found to reduce Club Root infection even when the slime fungus is present in the soil. One ounce to ten gallons of water is recommended for the prevention of Club Root in cabbage seedlings. The first application should be made as soon as the plants are through the soil. Four or five additional applications should be given at weekly intervals. Cauliflower seedlings are more subject to injury from corrosive sublimate than are cabbage seedlings. It is, therefore, advisable to use a greater dilution, one ounce corrosive sublimate in fifteen gallons of water for the first application and one ounce in twelve gallons for the others. In preparing the corrosive sublimate solution, dissolve the required amount of the powder in a little hot water and then dilute to the required strength with cold water. Prepare the solution in an earthen or wooden vessel as the

corrosive sublimate corrodes metal. A watering can with the sprinkler removed can be used to apply the corrosive sublimate along the rows so as to moisten the soil around the roots of the plants. If a few diseased plants are found in the field they should be burnt at once. If the soil becomes infested a long rotation of crops should be practiced. Plants belonging to the mustard family should not be grown in such soil oftener than once in six or eight years. If it is impossible to follow a long rotation of crops, and cabbage, cauliflower or turnips must be planted in infested soil, an application of hydrated lime or quick lime should be given six or eight weeks before the plants are set in the field. The field should be ploughed and enough hydrated lime (or quick lime, if preferred) scattered over the soil and harrowed in to produce an alkalinity slightly above neutral (pH 7.2). On some soils only a few hundred pounds per acre are necessary while on others as much as three tons per acre are required. Soil samples



Club Root of Cabbage (Original)

may be sent to the Chemistry Department, Ontario Agricultural College, to have determined the amount of lime per acre necessary to apply to any given field to make the soil alkalinity slightly above neutral. The kind of lime is very important. Experiments have proved that only hydrated lime or quick lime can be used profitably in the control of Club Root. Varieties of turnips resistant to Club Root are now available to growers who have trouble with this disease.

Blackleg of Cabbage—This disease is not confined to cabbages but is seen also on cauliflowers, Brussels sprouts, Swede turnips, kohlrabi, kale, rape, radish and several other cultivated plants belonging to the mustard family. In this Province cabbage and cauliflower are the only crops which are severely affected by this disease.

Symptoms—Plants may show the disease in the seed bed or in the field. Near the base of the stem are seen oval, depressed, light brown cankers. These enlarge and girdle the stem. The affected tissues turn black and the stem and roots decay. The blackening of the base of the stem has led to this disease being called Blackleg. Light brown spots may also appear on the leaves. In the cankers on the stem and in the spots on the leaves, numerous black dots (the fruiting bodies of the fungus) may be seen. Badly diseased plants may wilt. Sometimes the edges of the leaves turn bluish red in colour. If the stems and roots of the older plants decay the weight of the heads causes them to lean or fall over. Affected plants usually die in a comparatively short time but in damp soil they may live for a long time and even form heads.

Cause—*Phoma lingam* (Tode) Desm. is the fungus responsible for this disease. It passes the winter as fungus threads (mycelium) in the seed and as spores and fungus threads on the seed, and with the cabbage refuse in the soil. This fungus remains alive in the soil as long as any particles of cabbage or cauliflower stalks are left intact. It is disseminated in soil or manure containing cabbage refuse. Spring freshets carry the spores over large areas of a field or from one field to another. It is also spread on cultivating tools and by insects. The fungus appears to require abundance of moisture before it will develop rapidly, as the severity of the disease appears to be in direct proportion to the amount of rainfall in the early summer.

Control—Arrange a rotation of crops in which cabbage, cauliflower and other plants belonging to the mustard family are not grown on the same soil oftener than once in every four years. Rake up and burn the refuse from the diseased crop. Do not use seedlings from a seed bed in which there is any indication of Blackleg. Use non-infected seed. Such seed can now be secured from the Puget Sound section of the United States where the disease does not normally occur. If the source of the seed is unknown it is advisable to treat it with corrosive sublimate or hot water. The directions for treating the seed with corrosive sublimate are as follows: Use a solution of corrosive sublimate of the strength of 1-1000 by weight, which is prepared by dissolving one tablet in a pint of water, or an ounce of corrosive sublimate powder in 6 gallons of water. Place the seed in a cheesecloth bag. Do not fill the bag more than half full. Then immerse it in the solution for twenty to thirty minutes. After this rinse the seed thoroughly in clean water, then spread it out to dry. Corrosive sublimate is a comparatively handy seed disinfectant but it does not give as complete control as does hot water. This is due to the fact that while it will kill all the fungus which adheres to the outside of the cabbage seed, it cannot kill the fungus threads (mycelium) within the seed. Corrosive sublimate corrodes metal and therefore earthen or wooden vessels should be used to mix it in. Seed may be disinfected by immersing the bags in water heated to a temperature of 122° F. for 30 minutes. When the bags are immersed in the water it should be kept stirred constantly and the temperature maintained at 122° F. by adding, from time to time, small amounts of boiling water. After the bags are removed from the hot water they should be dipped in cool water, after which the seed should be spread out to dry. This treatment is very effective but it reduces the germination of the seed to a very considerable extent.



Bacterial Wilt of Cruciferae (Black Rot of Cabbage)

1 and 2. Views in a cabbage plantation, showing numerous cases of the disease in all stages of development.

BACTERIAL WILT OR "BLACK ROT" OF CABBAGE AND CAULIFLOWER

This is a bacterial disease of the veins (a vascular disease) of cruciferous plants—cabbage, cauliflower, kohlrabi, Brussels sprouts, broccoli, turnips, rape, kale and radishes.

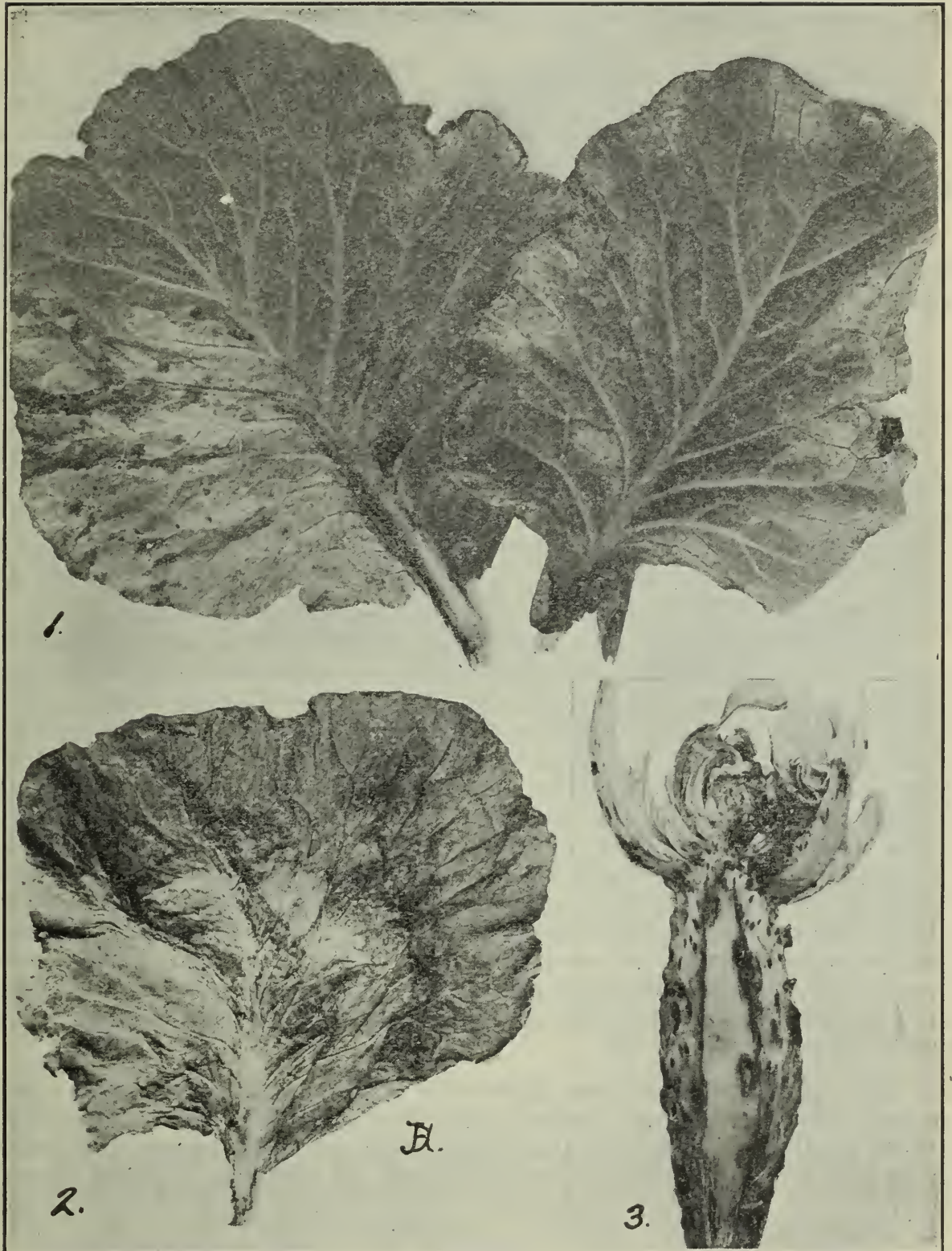
In vascular diseases the bacteria invade the veins or water-conducting vessels of the plant and cause wilting by plugging the veins.

Symptoms—When infection occurs in the seedling stage or in very young plants, death of the plant usually results. Those that do survive remain stunted and fail to produce a root in the case of the turnip and radish, or fail to form a head in the case of cabbage and cauliflower. Primary infection is through the veins of the leaf which turn brown as the bacteria advance down them towards the stem, eventually reaching the middle of the plant and spreading to adjacent parts. This is followed by secondary invasion of the plant by other kinds of bacteria which soon cause a rot with an objectionable characteristic smell. Infected leaves are characterized by yellow to brown irregular shaped blotches, somewhat transparent, and usually starting near the outer margin of the leaf, later progressing towards the middle until the entire leaf is involved. The network of veins become blackened to such an extent that they may be seen as black threads, even in the thick white tissues surrounding them in the midrib. If the stems of infected leaves are cut across, the veins will appear as small black dots instead of white or greenish-yellow dots as they appear in healthy sections; in longitudinal sections of diseased stems the veins appear as black streaks. When diseased leaves are broken from the stem, the veins connecting the stem and leaf appear as black dots. Wilting of the leaves may occur after the bacteria have entered the central stem of the plant. This condition is brought about by the large number of organisms plugging the veins and interfering with the circulation of the sap.

Cause *Phytophthora campestri* (Pammel), Bergey et al, is the cause of this disease. The organism is carried over from year to year chiefly in the soil and in manure containing diseased crop refuse. Once a diseased crop has been produced in a field the soil remains infested for several years. Infected seed is known to carry the organism to disease-free soil.

Most of the infections occur through the water pores of the leaf, which are situated in groups around the margin. During cool nights these water pores exude dew-like drops and these may persist for some time during moist weather. When the disease producing organisms reach these droplets they multiply rapidly and gain entrance to the veins, causing infection. Sometimes the organism gains entrance to the plant through wounds. Aphids, slugs and other insects have been shown to transmit the bacteria from diseased to healthy plants. By these methods of transferring the organism many individual infections may occur on a single leaf, but it requires from 7 to 20 days after the entry of the organism before the symptoms appear.

Control—It will be obvious from the above description that the old and still common practice of removing diseased leaves from an infected plant does not control the spread of the disease. Infected plants and seedlings should be pulled and burned. If such material is thrown on the manure pile the infection will, in all probability, be transferred with the manure. Infected cabbage heads should never be stored after harvesting since the disease may spread during storage. Rotation of crops is recommended, and cruciferous plants should be eliminated from the rotation for 4 or 5 years.



Bacterial Wilt of Cruciferae (Black Rot of Cabbage).

1. Cabbage leaves affected with the bacterial wilt or black rot. The lighter-shaded areas around the outer edge of the leaves are the diseased parts showing natural inoculation through the water pores on the edge of the leaves; the light-shaded areas were yellow.
2. The lighter-shaded part of the leaf near the base indicates the disease, and the blackened vascular bundles of the stem, where it is cut, indicate that the disease entered this leaf from the main stalk of the cabbage.
3. Cabbage stalk and stunted head; the blackened vascular bundles indicate that the disease was general throughout the plant. The leaf of Fig. 2 was taken from this plant.

The position of the seed bed should be changed from time to time, or the soil in it renewed or sterilized with steam or formalin.

Seed disinfection is recommended. This can be accomplished either by immersing the seed for 30 minutes in a solution of corrosive sublimate (mercuric chloride), 1 part by weight in 1000 parts of water (1 tablet to a pint of water), or in a formalin solution, 1 pint to 30 gallons for the same time.

In disinfecting the seed use cloth bags and only half fill them so that the solution will penetrate to all the seeds when they are immersed. After treatment rinse in clear water and spread out to dry.

CELERY

LATE BLIGHT OR SEPTORIA LEAF SPOT

This is the most common and most destructive celery disease in Ontario. In wet seasons it is very severe and ruins large quantities of celery. It is not usually noticed by the grower until the disease has become fairly well established on the plants, but a careful observer can often find a little of it in the seed bed or in the field shortly after the plants are set out.

Symptoms—The lower leaves usually show the first symptoms of the disease. On these brown spots develop and in these spots numerous black specks may be seen. These black specks are the fruiting bodies of the fungus. They are called pycnidia and contain the spores. There are two forms of Late Blight, the large spot form and small spot form. In the large spot form, the spots, when mature, are definite in outline, brown to reddish-brown in colour with a darker margin and with pycnidia scattered in the centre. These spots may increase in size until they have a diameter of one-quarter inch or more. In the small spot form, the spots are indefinite in outline, brownish-black or even grey in colour. The pycnidia are found within the spot or in the tissue surrounding it. The diameter of these spots is seldom more than one-eighth inch. When this form of the disease is very bad, the characteristic spots may not develop but the whole leaf may become covered with minute black specks (pycnidia). Such leaves become dry and wither up.

The small spot form also affects the stems causing somewhat water-soaked rusty-brown areas studded with black pycnidia. This phase of the disease is often erroneously called Celery Rust by the growers. If diseased stems are put in storage secondary fungi, or bacteria, develop causing decay.

Cause—The large spot is caused by the fungus *Septoria apii* (Br. & Cav.) Chester. The small spot is caused by the fungus *Septoria apii-graveolentis*, Dorogin. Numerous spores are produced in the black specks (pycnidia) embedded in the surface of the leaves. When the plants are wet with rain or heavy dew the spores are discharged and spread by means of water, wind, insects, implements, men and horses. The fungus lives over winter on the diseased leaves and stems left lying on the field or in the seed beds.

Control—Spraying with Bordeaux or dusting with copper-lime dust is the most reliable means of controlling this disease. Spraying has given the best results in experiments carried on at the college, but some growers



Late Blight of Celery (Small Spot Form).

(Courtesy of the Department of Plant Pathology, Cornell University).

have had satisfactory results with dust applied frequently with high pressure.

In addition to spraying or dusting the following precautions should be taken, and those who are growing only a small quantity of celery may be able to do so without spraying or dusting. Rake up and burn any diseased leaves and stems and follow a system of crop rotation. This allows the refuse from the celery crop to decay before celery is grown again on the same soil. Plant the celery in well drained land. Do not cultivate when plants are wet and keep the soil from getting into the crown of the young plants.

Spraying—Give two applications when the plants are still in the seed bed using Bordeaux mixture of the strength of 3 pounds of bluestone and 4 pounds of hydrated lime to 40 gallons of water. The first application should be made when the plants are from two to three inches high and the second application given a short time, three or four days, before setting the plants out in the field. The field spraying should be started a week or

ten days after the plants are set out. For the field applications use Bordeaux mixture of the strength of 4 pounds of copper sulphate, 5 pounds of hydrated lime and 40 gallons of water. Applications should be made at an interval of a week or ten days during the season. The wetter the weather the greater the number of applications that will be required. When the plants are small 40 gallons of the spray mixture will be sufficient for an acre but when the plants are large it will require two or three times this much. It is very important that the Bordeaux should be applied under high pressure. The sprayer should be rigged with three nozzles to each row, one from the top and one from each side. Late Blight spreads most rapidly during wet weather. It is therefore important to see that the Bordeaux is on the plants before rain comes rather than after.

Dusting—Use 20 per cent. copper-lime dust. Give two applications as described above while the plants are still in the seed bed and repeat at intervals of from 3 to 10 days after the plants are set out in the field. In very wet weather, if blight gets started, it may be necessary to apply the dust as often as twice a week. The best results from dusting are secured by using liberal quantities of dust and applying it under high pressure when the plants are damp with dew.

EARLY BLIGHT OR CERCOSPORA LEAF BLIGHT

This disease compared with Late Blight of celery is of comparatively little importance in Ontario. It is seen to some extent every year and occasionally it does considerable damage.

Symptoms—The name "Early Blight" is misleading as this disease does not usually appear until later in the season than the so-called "Late Blight." Usually it does not appear until the plants are from 6 to 8 weeks old while Late Blight is often seen shortly after the seedlings come above the ground. On affected leaves small yellow spots develop. These enlarge and become somewhat circular to angular in shape with a brown margin. The central part of the spots change from yellow to ash-grey in colour. When numerous they run into each other in irregular patches.

Cause—*Cercospora apii* Fres. is the fungus which causes this disease. This fungus produces numerous spores on the surface of the leaves when the weather is hot and wet after a period of drouth. These spores are spread from plant to plant by rain and wind and during cultivation. The fungus is carried over the winter as hardened masses of mycelium (sclerotia) in the tissues of the diseased leaves.

Control—The recommendations given for the control of Late Blight of celery apply in all their details to Early Blight.

CELERY YELLOWS

This disease was reported as occurring in Ontario for the first time in 1924. In the United States celery yellows has caused serious loss to celery growers especially in the State of Michigan. It is recorded as being most serious on certain strains of golden self blanching celery. These are said to be more susceptible than white plume and other winter varieties.

Symptoms—Affected plants are stunted with yellow or yellowish-white leaves. They usually die prematurely. The veins (vascular bundles) of the roots and heart are reddish-brown in colour.

Cause—This disease is caused by a species of *Fusarium*. This fungus is a soil organism, being carried over in the soil from year to year. Land badly infested with it is said to be worthless for the growing of many of

the finer strains of golden self blanching celery. On account of the serious losses which may be caused by this disease Ontario celery growers should be on the watch for it.

Control—In Michigan it has been found that this disease can be avoided by growing resistant strains of golden self blanching celery. Such strains have been developed in Michigan and if Ontario celery growing soils become infected with the fungus which causes yellows, it may be necessary to introduce these resistant strains into this Province, or to develop here in the Province other resistant strains.

BACTERIAL SPOT DISEASE OF CELERY

This disease occurs on all varieties of celery grown in Ontario. When severe it disfigures the leaves to such an extent that the celery is not readily saleable.

Symptoms—This leaf spot is characterized by irregular circular rusty brown spots, rarely exceeding a quarter of an inch in diameter. These spots closely resemble those of late blight but may be distinguished from them by the absence of the little black specks (fruiting bodies) of the fungus which causes late blight. The disease is usually confined to the leaf blades, causing disfiguration and sometimes death of the leaf.

Cause—This disease is caused by the bacterial species *Phytophthora* *apii* (Jagger), Bergey et al, which enters the leaf through the breathing pores (stomata) or through wounds made by insects.

Control—Spraying experiments have shown that liquid Bordeaux mixture will satisfactorily control this disease. See directions for spraying celery under Late Blight of Celery, page 16.

CORN

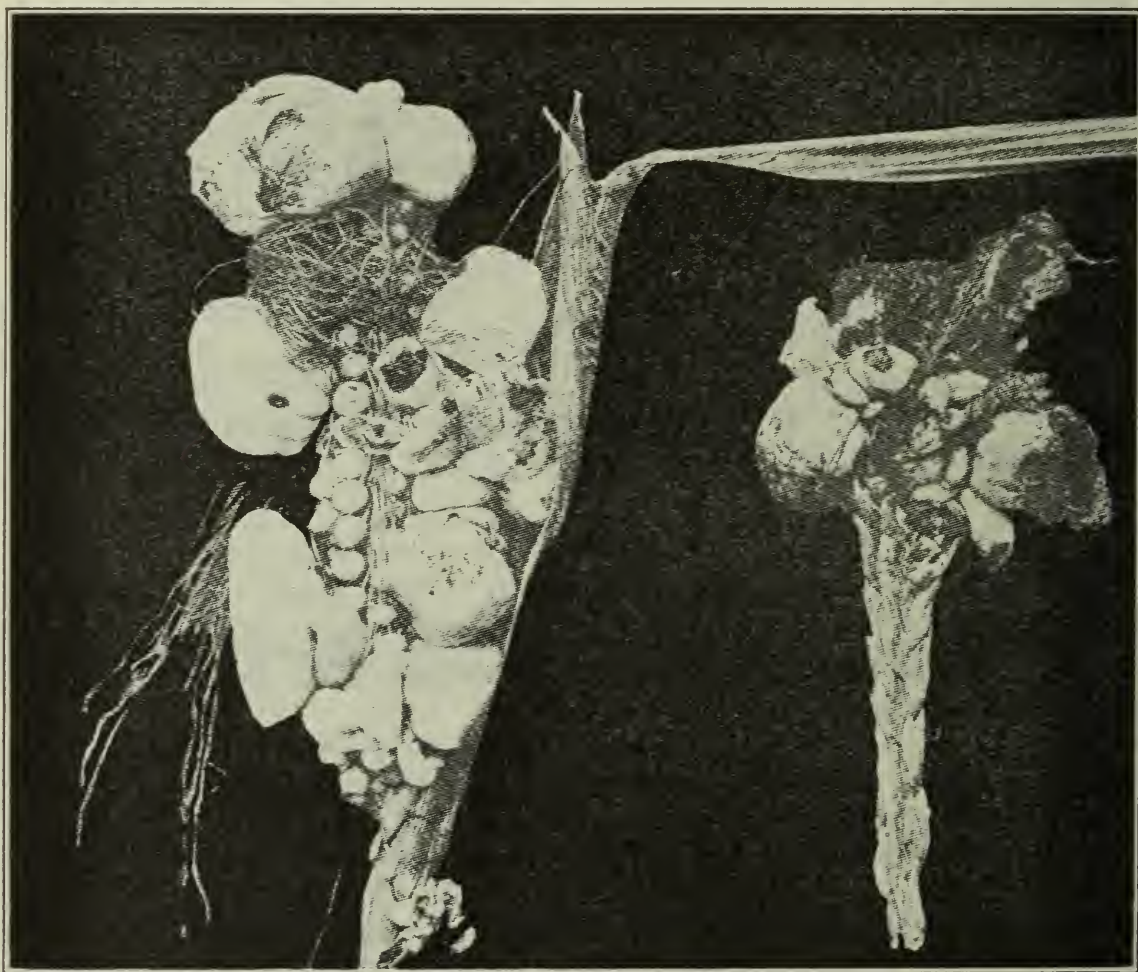
CORN SMUT

This smut is very frequently seen in Ontario and nearly everyone who grows any corn is familiar with it. Sweet or table corn seems to be especially susceptible to it.

Symptoms—Corn smut attacks the ears, stalks, leaves and tassels. On the parts affected it produces peculiar growths frequently spoken of as "boils." These "boils" are sometimes six inches or more in diameter. In the early stages they are green, later they are white and polished, and finally they become dark coloured and ruptured, exposing a brownish black mass of powder consisting of millions of spores. Corn smut usually appears on the plants when they are about three feet high, but on very susceptible varieties like Golden Bantam it is sometimes seen when the plants are less than a foot high.

Cause—The fungus which causes corn smut is *Ustilago zeae*, (Beckman) Unger. As soon as the "boils" mature and rupture, the spores are scattered by the wind and other agencies. In the soil or in manure they germinate and produce great numbers of secondary spores which may infect any of the tender growing tissues of the corn plants. Thus the smut is spread during the growing season. The fungus is carried over the winter as spores in the soil and in manure. These may be contaminated in various ways. The spores may be scattered by the wind or the spore mass may be left in the field, or thrown on the refuse or on the manure pile. It is believed that the spores of this fungus may not only live in the manure pile but that they may actually grow and increase in number in warm fermenting manure.

Control—No seed treatment will prevent corn smut as the fungus which causes it is carried over the winter as spores in the soil and in manure. Control measures are not very satisfactory. The cutting out and burning of all smut growth “boils” as soon as they appear is recommended for gardens or small areas of sweet corn. This should be done before they mature and break open, and care should be taken in handling them that they are not broken open and the spores they contain scattered in the field. This practice should be followed every year. If possible practice a rotation of crops. The spores of this fungus will not live for many years in the soil and those which are in the soil cannot injure any other garden crop. After three or four years corn may be planted again with less danger as many of the spores will have lost their vitality by this time. Avoid fresh manure with the corn crop as it is very likely to contain live smut spores.



Corn Smut on Ear and Tassel. (About one-half natural size).

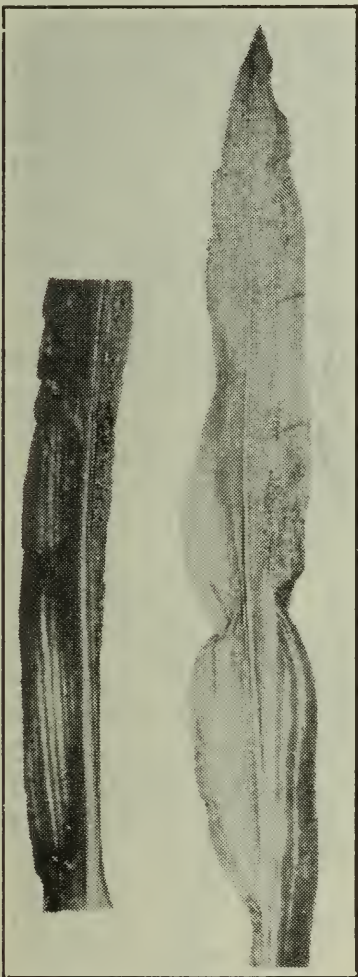
STEWARTS DISEASE OR BACTERIAL WILT OF SWEET CORN

This disease was not noticed to any extent in Ontario until 1932. That year sudden outbreaks occurred in the counties of Essex, Kent and Norfolk where the degree of infection varied from 3 to 70 per cent. The disease also occurred in Elgin county but with less severity. The casual organism was found in 13 per cent. of imported and home grown seed, examined at that time. It is deemed advisable to include an account of this disease here, so that, in the event of its recurrence, it may be recognized.

Symptoms—This is a disease of the veins (vascular disease) which results in wilting, even when there is no lack of moisture in the soil. The first signs of the disease to appear are long, wilted streaks, lighter green

in colour than adjacent still healthy parts of the leaf blade, but without conspicuous yellowing. These streaks are usually noticed first at the lower part of the plant, where infection comes from the seed, soil, and other sources. The disease spreads from such points until the whole plant wilts and dies, but even after death of the plant the green colour of the leaves usually persists. In some instances the tassels may develop prematurely then die before the plant as a whole succumbs. When the stem of an affected plant is cut across, yellowish beads of sticky bacterial slime will ooze from the veins. This slime does not ooze to the uncut surface of the plant except through breathing pores in the skin of inner husks of badly diseased plants. While this is primarily a disease of the veins, the bacteria may, in advanced stages of the disease, invade all parts of the plant. Both sweet and field corn may be affected but sweet corn is the more susceptible.

Cause—This disease is caused by the bacterial organism *Phytomonas stewarti* (E. F. Smith) Bergey et al, which enters the plant from the seed, or through wounds made by the 12-spotted cucumber beetle which carries the organism from infected plants; or through leaf wounds made by the brassy flea beetle, and the toothed flea beetle. The organism overwinters in infected seed.



Corn leaves affected with Bacterial Wilt.
(Courtesy of Dr. Berkley).



Corn affected with Bacterial Wilt.
(Courtesy of Dr. Berkley).

Control—Seed treatment has not proved to be satisfactory in controlling this disease. It would appear that the best way of avoiding this trouble is to be careful in the source of seed. Whenever possible, seed should be secured from fields free from the disease. If this disease should again be troublesome in Ontario it will be necessary to endeavour to grow resistant strains of corn. From work done at the Connecticut Agricultural

Experimental Station* it would appear wise to select seed from disease-free plants in areas where the disease is present. The progeny of these plants is more likely to be resistant.

*Circular 96. Connecticut Agr. Sta., New Haven, U.S.A.

CUCUMBERS

BACTERIAL WILT OF CUCUMBERS

This is a widely spread and destructive disease of cucurbits. The cucumber is the most susceptible, but muskmelons, pumpkins and squash may also be affected by it.

Symptoms—The most striking symptom of this disease is a wilting of the plant first noticed at the extreme tips of the runners. The affected leaves and other parts become limp and lose their bright green colour and take on a dirty, yellowish-green appearance. Since this is a disease of the veins the whole plant eventually wilts. If the diseased stem is cut through, a clear, sticky, slimy liquid will ooze out from the veins at the cut surfaces. This sticky, slimy sap is one of the most characteristic symptoms of the disease.

Cause—This wilt disease of cucumbers is caused by the bacterial organism, *Erwinia tracheiphila* (E. F. Smith) Holland. The organism is transferred from diseased to healthy plants by the striped and 12-spotted cucumber beetles. It is carried over from season to season in the bodies of the overwintering striped cucumber beetles. It has been shown repeatedly that the organism is not carried over in the soil. It has also been shown that it is not transmitted through the seed, and all attempts to produce the disease by artificial inoculation have failed.

Control—The most important point in the prevention of this disease is the control of cucumber beetles which harbour and spread the causal organism. Professor Caesar recommends dusting the plants from above with gypsum (land plaster) and arsenate of lime (calcium arsenate) in the proportion of 20 parts of the former to 1 part of the latter. If wilt is to be prevented apply this dust as soon as the beetles are observed, and repeat as often as may be necessary to protect the plants from the beetle. Usually 3 or 4 applications are all that are required. It is also advisable to remove and burn or bury all infected plants to prevent insects feeding on them and spreading the disease. *"It has been found that the American varieties, such as Chicago pickling, and other related pickling strains are much less susceptible than are similar varieties originating in Europe, such as Half Long Prolific, Oblong Green Pickling, King William, Short Green Parisian, and others. Where wilt has been severe, the American varieties should be chosen though they are far from immune."

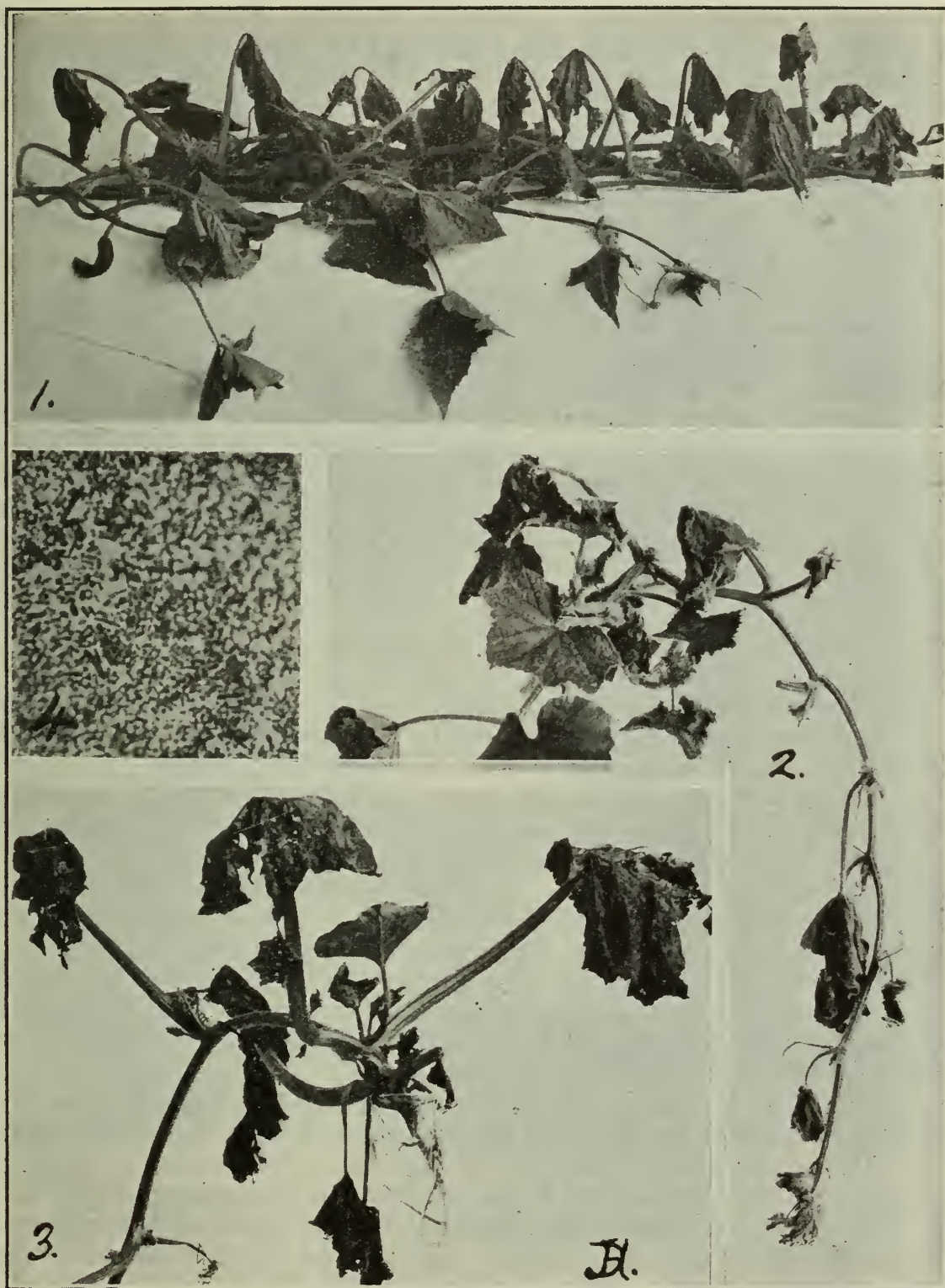
ANGULAR LEAF SPOT OF CUCUMBERS

This disease has not caused such serious losses to cucumber growers in Ontario as the wilt disease, but it often causes considerable damage and warrants careful control.

Symptoms—When young seedlings are infected the seed leaves show small water-soaked spots. Later, these become brown and die. If the seedlings survive, the second or true leaves become infected, and develop the characteristic spots. These spots are at first darker green than the

*Bulletin 206. New York State College of Agr., at Cornell University, Ithaca, N.Y.

surrounding tissue, and are water-soaked in appearance, later they turn dry and brown, and drop out, giving a ragged appearance to the leaf. Because of this last symptom the disease is often referred to as the "shot-hole" disease. The spots are always irregular or angular in shape because



Bacterial Wilt of Cucurbits.

1. Bacterial wilt of cucumber.
2. Bacterial wilt of cucumber.
3. Bacterial wilt of squash.
4. Stained microscope preparation from the viscous slimy exudate of a vascular bundle of a wilting cucumber plant, showing the bacteria (*Erw. tracheiphila*), (X 1000 di).

they occur between the veins. If one examines these spots before they become dry, there will be noticed a milky white ooze or exudate which is a teeming mass of the bacteria. When the fruit-producing flowers are affected they darken in colour, dry up and fail to set fruit. When the fruit is affected, small circular water-soaked spots appear, mostly on the upper surface, and on these appears a resinous exudate. From this stage very little development of the spots takes place on the surface of the fruit, but the rot progresses into the fruit, eventually reaching the veins and the walls of the seed chambers (placentae), changing the interior of the fruit to a soft mushy mass.

Cause—The bacterium *Phytophthora lachrymans* (Smith & Bryan) Bergey et al, causes this disease. It overwinters on infected seed and in the soil. It is spread from diseased to healthy plants by insects, wind and pickers. The organism gains entrance to the plant through the breathing pores (stomata) of the leaves and fruit.

Control—Seed treatment is the most effective method of control. Simply tie the seeds loosely in a cheesecloth bag and soak them for 10 minutes in corrosive sublimate, 1 part to 1000 parts of water (1 tablet to a pint), rinse in several changes of fresh water and dry them. Remember that corrosive sublimate is a deadly poison. When the disease is found on the foliage, its spread may be checked by spraying with Bordeaux mixture. Crop rotation is recommended in cases where the disease is established. Cucumbers should be omitted from the rotation for at least two years, if this is possible. It is important also to avoid working among the vines when they are wet with rain or dew.

MOSAIC OF CUCUMBERS

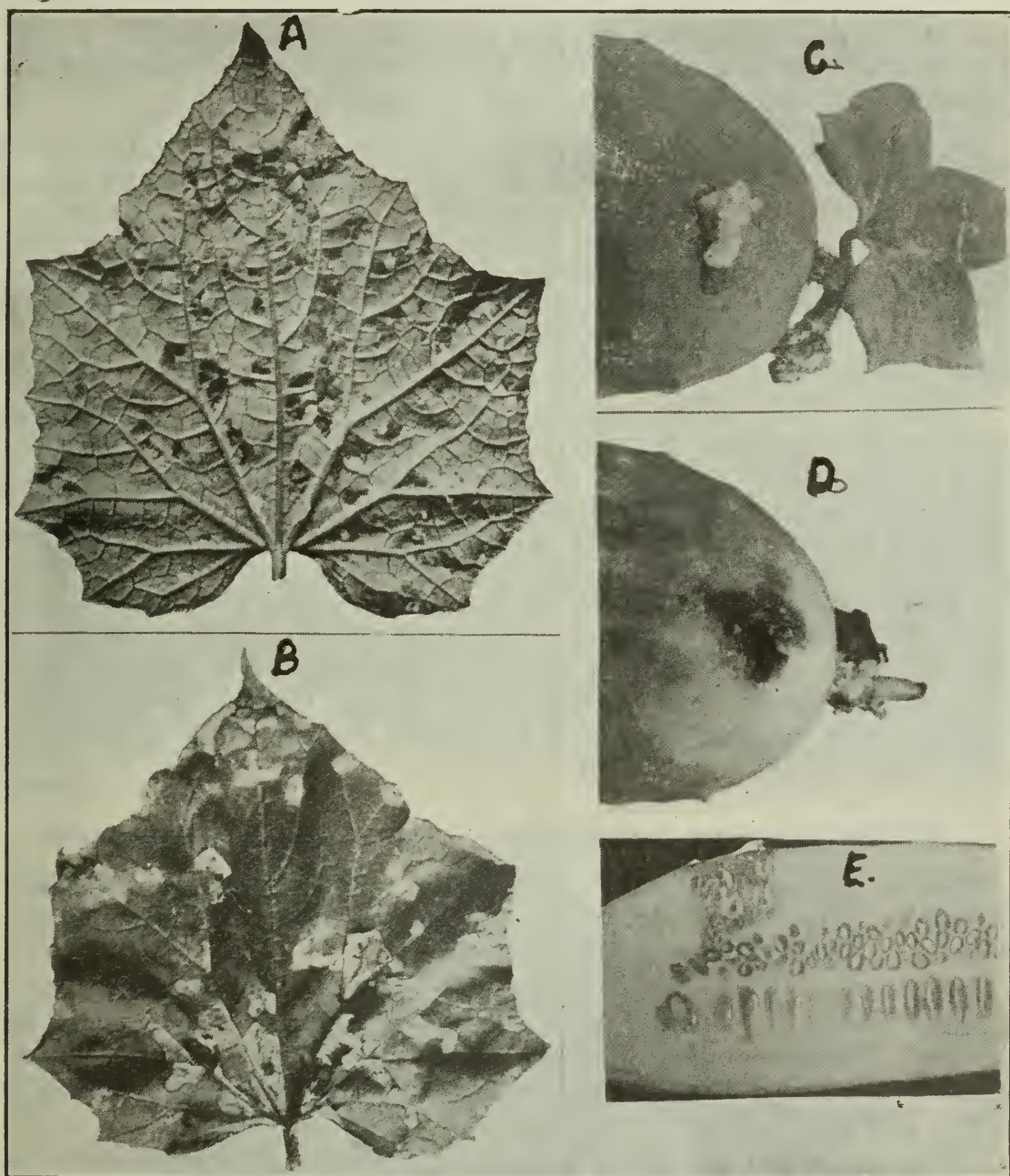
This disease is often seen in Ontario. It frequently causes very serious loss to cucumber growers. It is known by various names such as Mosaic, White Pickle, White Wart and Nubbin disease.

Symptoms—Plants may show symptoms of the disease in any stages of their growth. If seedlings are diseased the seed leaves (cotyledons) turn yellow. The leaves are mottled yellow and green and the plant is much dwarfed. There is little or no fruit set and the plant usually dies early. Generally plants do not show symptoms of the disease until they have passed the seedling stage. The peculiar yellow and green mottling of the foliage is the first symptom. The upper surface of the leaf is wrinkled and its edges curled downward. The affected leaves are dwarfed and the fruit does not set properly. If the fruit is affected it shows alternate irregular yellow areas and warty green spots.

Cause—This is another of the so-called virus diseases. The virus which causes it is not carried over in the soil or in the seeds of the cucumber or other cultivated vegetables. It has been demonstrated, however, that it can live over the winter in the seed of the wild cucumber (*Echinocystis lobata* Torr. & Gray.) and in the perennial roots of the milkweed, pokeweed, ground cherry and catnip. Aphids and the striped and twelve-spotted cucumber beetle serve to transmit the virus from diseased to healthy plants. It may also be transferred by rubbing together healthy and diseased leaves until there is bruising, and by other methods in which the plant sap may be transferred from a diseased to a healthy vine.

Control—No entirely satisfactory control measures have been devised. All wild cucumber, milkweed, pokeweed, catnip and ground cherry within fifty yards of the greenhouses and cucumber fields should be destroyed if possible. Cucumber beetles and aphids should be controlled by dusting.

If infected plants are found in the crop early in the season they should be pulled up by the roots, carefully removed and burned. It does not appear to be worth while to destroy plants that become diseased after they are nearly full grown.



- A—Cucumber leaf eight days after inoculation with *Phytomonas lachrymans*. The bacterial exudate has dried down into white crusts.
- B—Cucumber leaf twelve days after spraying with *Phytomonas lachrymans*. Diseased tissue shrivelled and spots falling out.
- C—Green cucumber fruit photographed six days after inoculation with *Phytomonas lachrymans*. There is an exudate at the point inoculated while the remainder of the fruit is sound.
- D—Same as C, after twelve days; fruit ripening but still sound except at point of inoculation.
- E—Section of green cucumber fruit ten days after inoculation. Tissue decayed only in vicinity of inoculation.

(After M. C. Bryan)

POWDERY MILDEW OF CUCUMBERS

This mildew is seen on squash, cucumbers and melons. In Ontario it is seldom of any importance in the field, but it sometimes becomes troublesome on cucumbers grown under glass.

Symptoms—Circular powdery spots are seen on the leaves and young stems. At first the tissue of the spots remains normal but finally turns brown and dried. In severe attacks the leaves may be killed. If all the foliage of the vine is covered with mildew the plant is weakened, has a yellowish colour and most of the fruit is rendered useless.

Cause—*Erysiphe cichoracearum* D.C. is the name of the fungus causing this mildew. This fungus produces two kinds of spores, summer spores (conidia) which are produced in enormous quantities in chains on the surface of the leaves and which give to the spots their powdery appearance. These summer spores serve to spread the fungus during the growing season. The second form of spores known as ascospores are produced in little black fruiting bodies (perithecia) on the surface of the leaves and petioles. They serve to carry the fungus over from season to season.

**Control*—This mildew can be prevented by dusting with sulphur or spraying with Bordeaux at intervals of a week or ten days. Sulphur dust is most effective for combating powdery mildew in greenhouses. Sulphur dusting materials containing fifteen to twenty per cent. free sulphur are as effective as high grade dusts containing sixty to ninety-five per cent. free sulphur, and are safer, cheaper and therefore preferable. *E. F. Guba states that dust should be applied at the rate of about five to six pounds to a house 280 x 40 feet. Bordeaux mixture of the strength of one pound of copper sulphate, two pounds of hydrated lime and forty gallons of water can be safely used. Experiments have shown that if greenhouses are fumigated with hydrocyanic acid gas when Bordeaux is present on the leaves foliage injury may result.

ANTHRACNOSE OF CUCUMBERS, SQUASH AND WATERMELONS

This is a disease which is frequently seen in Ontario, especially on cucumbers. It is seldom serious in the field but occasionally becomes very severe on cucumbers grown under glass.

Symptoms—On the leaves of affected plants brown dead circular spots are seen. These are frequently very numerous so that the whole leaf is destroyed. On the stems elongated light brown areas are observed. On affected fruit, especially on the watermelon, water soaked sunken spots appear. These often have pink centres.

Cause—Anthracnose is caused by the fungus *Colletotrichum lagenarium* (Pass.) E. & H. This fungus remains alive in the old diseased tissue in the soil in the field or in the greenhouse. It is also known to be carried over in and on the seed.

Control—No satisfactory control measures have been discovered. As the fungus lives over at least one season in the diseased plant refuse left in the soil, a rotation of crops is essential. Seed treatment is also recommended. This consists of dipping the seed in corrosive sublimate (one ounce in six gallons of water) for five minutes then rinsing it thoroughly in running water and drying it. Spraying with Bordeaux mixture is also recommended. Spraying cucumbers under glass has not been profitable in

*"Control of Cucumber Powdery Mildew in Greenhouses," by E. F. Guba, Phytopathology, Volume 8, No. 10, October 1928.

the limited experiments carried on in this Province as the frequent and heavy sprayings required to control the disease have caused injury to the foliage and fruit.

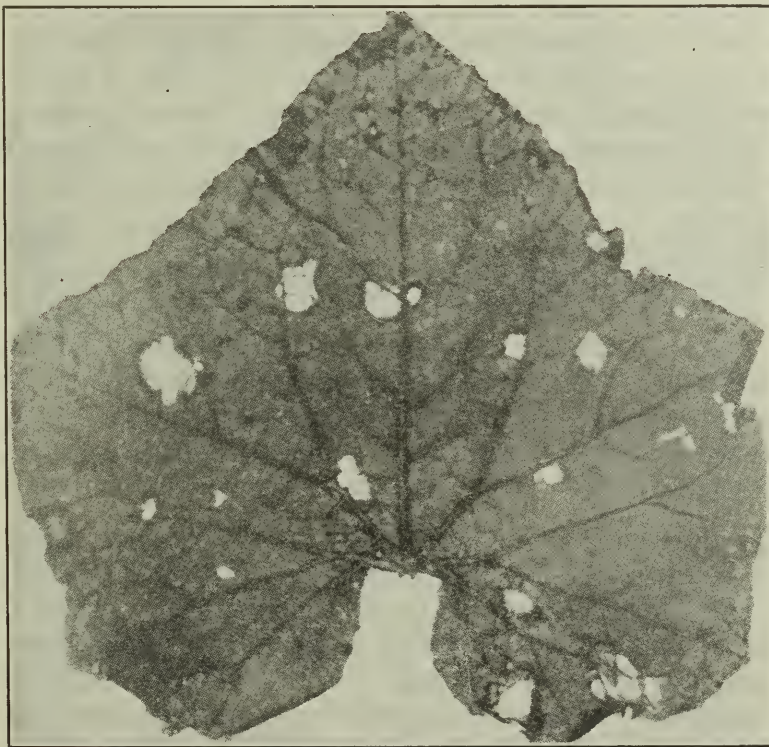
DOWNY MILDEW OF CUCUMBERS

This disease is quite frequently seen in Ontario. It affects not only cucumbers but also squash, melons and pumpkins.

Symptoms—Irregularly shaped yellowish spots appear on the upper sides of the leaves. If a leaf is examined on the lower surface a downy fungus growth will be seen around the margin of the spots. If weather conditions are favourable these yellowish spots rapidly enlarge and finally the entire leaf withers up and dies.

Cause—*Peronoplasmodora cubensis* (B. & C.) Wint. is the fungus which causes this disease. This fungus spreads during the wet weather of the summer months by means of numerous spores produced on the under surface of the affected leaves. Just how this fungus passes the winter is not known. It is possible that it may survive the winter in greenhouses and spread to outdoor plants when the latter begin to grow. There is no evidence that it lives over in the soil outdoors.

Control—Spraying with Bordeaux mixture or dusting with copper-lime dust will control this disease. Begin spraying or dusting early. In comparatively dry weather apply the Bordeaux or dust every ten days. If, however, the weather is wet more frequent applications will be necessary. When the plants are young weak Bordeaux should be used (two pounds copper sulphate, three pounds hydrated lime and forty gallons of water). Later when the plants have formed runners the 4-5-40 formula can be used. In spraying or dusting it is important that both sides of the leaves should be covered with the fungicide. Frequent and heavy applications of Bordeaux applied to cucumber plants under glass may cause injury to foliage and fruit.



Downy Mildew of Muskmelon
(After F. C. Stewart)

LETTUCE

LETTUCE DROP

This is a serious disease of lettuce. It is frequently seen in Ontario on lettuce grown under glass.

Symptoms—The first symptom usually observed is the wilting of the outer leaves which droop and fall flat on the ground. All the leaves of the plant are soon affected in the same way and in a few days the entire plant is dead and lying flat on the ground. This sudden and entire collapse of the plants has given rise to the name "Drop." The disease usually appears on the stem near the surface of the soil as a soft water-soaked spot that spreads downward until the roots are decayed and upward until the bases of the leaves are affected.

Cause—The most common cause of leaf drop is the fungus *Sclerotinia libertiana* Fckl. This fungus forms innumerable black hard bodies termed sclerotia. These are a resting stage of the fungus and they serve to carry it over from season to season.

Control—Soil sterilization is the most important control measure. Either steam or formaldehyde may be used (see pages 64 to 68). If a few diseased plants are seen in a bed they should be removed, taking care not to scatter any of the diseased tissue or sclerotia. After the plants are removed soak the vacant spot with a bluestone solution, one pound in six gallons of water. Keeping the top soil well stirred and as dry as good growth of lettuce will permit, helps to prevent the development of this disease. If possible a system of cropping should be so arranged as to alternate crops of lettuce with less susceptible vegetables such as radishes and tomatoes.

THE LONDON LEAF LETTUCE DISEASE

This disease has caused much trouble to the growers of leaf lettuce under glass in the neighbourhood of London. It has also been observed to a lesser extent in greenhouses in other parts of the Province. Mr. F. B. Stewart, under the joint supervision of the Departments of Botany and Horticulture, made a careful study of this trouble, and it is from his report that the following account of it has been prepared.

Symptoms—The London Leaf Lettuce Disease is characterized by a number of striking symptoms. This disease usually appears in irregular patches here and there throughout the bed of lettuce. Quite often healthy plants may be found growing among diseased plants. In severe cases the entire crop is affected. The individual plants in a diseased bed of lettuce, nearing maturity, appear to be more distinct, whereas the plants in a healthy bed seem to blend into one another, making it difficult to pick out individual plants.

Usually the disease is first apparent by a general stunting about the second or third week after the plants are set out into the permanent beds. The growth of the plants seems to be at a standstill. After this delay they may begin to grow again, but in many cases are so badly checked that even at best they are far behind normal plants. These infected plants first become light-coloured. This is followed by a mottling of light yellow and dark green which becomes more pronounced as the plants grow older. Sometimes the young plants become infected before they are planted into the permanent beds. In this case the leaves usually become puckered and

distorted before the mottling of light yellow and green appears. The petioles of these plants usually become long and narrow. No further growth takes place except for the production of some small malformed twisted leaves. When plants become diseased late in their growth period the symptoms are less marked. It is often difficult to tell the diseased plants from healthy plants without using transmitted light. The leaves are only lightly mottled; the plants are somewhat stunted in most cases and are usually a little paler in colour but not enough to distinguish them from healthy plants.

Another important symptom by which this disease may be distinguished is by the appearance of the veins in the leaf. The veins in a diseased leaf are much more apparent and clear cut than those in a healthy leaf, and appear to be more numerous.

Cause—This lettuce disease is caused by one or more viruses, which are carried from diseased to healthy plants by two species of plant lice (aphids). The virus or viruses cannot be transmitted readily by mechanical means, that is, by touching diseased plants and then touching healthy plants, or by rubbing the juice from crushed, diseased plants on the leaves of healthy plants.

Control—Since aphids are probably solely responsible for the spread of this disease, control measures should be directed towards their elimination. It is believed that no lettuce plants for use in the greenhouse should be started outdoors, as in the open it is almost impossible to control aphids. Virus free plants can be secured by growing the young plants in the greenhouse. During August and early September the plants can be shaded from the sun. The young plants as soon as they appear above the ground should be dusted with a three per cent. nicotine lime dust and dusted every week thereafter until they are nearly mature (two or three weeks before harvesting), or the greenhouse should be fumigated each week with a commercial tobacco preparation, used according to the directions on the can.

DOWNY MILDEW OF LETTUCE

This mildew is very often found in Ontario on lettuce both in the field and under glass. It seldom causes much damage to field or garden lettuce, but sometimes injures lettuce grown under glass very severely. There is a great difference in the susceptibility of varieties of lettuce to Downy Mildew. Some varieties are much more susceptible than others. New York head lettuce is extremely susceptible. Big Boston and Hanson are reported as being resistant.

Symptoms—Yellow spots are observed first on the older foliage. These yellow spots or blotches are seen on the upper surface of the leaves which turn brown at the margin and fall. On the lower surface of the blotches a delicate white fungus may be seen. As the margins of the leaves often turn brown some growers call this disease Brown Margins. If young lettuce is severely attacked the plants are dwarfed, yellowed and useless for market purposes. Lettuce which is slightly affected by mildew is very likely to soft rot in transit and storage. This is one reason why growers have to be careful to guard against it.

Cause—Downy Mildew of lettuce is caused by the fungus *Bremia lactucae* Reg. This fungus is spread by means of numerous spores produced on the lower surface of the affected leaves. It is able to live in the soil of the beds for a considerable length of time but cannot withstand

freezing and thawing. Outside it lives over winter on wild lettuce which grows as a winter annual. The plants are infected in the fall and the fungus remains dormant in them until spring. In the greenhouse the fungus thrives best and causes most trouble when the difference between day and night temperatures is greatest and when the days are most cloudy.

Control—This mildew can be prevented to a very large extent by proper handling of the lettuce crop grown under glass. Light and air are important factors. The houses should be constructed so that plenty of air and sunlight are available. Temperature is also an important factor, and if this mildew is troublesome the houses should be kept three or four degrees higher at night than is recommended under normal conditions. The plants should be watered so as to wet the foliage as little as possible. As young plants are most susceptible it is recommended to spray them before transplanting with Bordeaux mixture (three pounds bluestone, four pounds hydrated lime, and forty gallons of water). The first spraying should be given several days before the seedlings are ready to be transplanted, and a second application should be given two or three days before they are transplanted. If the plants are properly handled subsequently, these two sprayings will protect them against mildew. Renewing the soil in the beds or sterilizing it with steam or formalin also aid in the control of this and other lettuce diseases.

BACTERIAL DISEASES OF LETTUCE

These diseases are considered as a group because their general symptoms may be similar, and because it is sometimes difficult to distinguish one from another. They are the cause of considerable loss to lettuce growers; losses range from five to eighty-five per cent. in both greenhouse and field crops. Furthermore, the same general unfavourable conditions under which the plants may be grown are inductive to each of the diseases. Under glass these are a stagnant, humid, warm atmosphere, excessive watering and poor ventilation; in the field the contributing factors are, addition to the soil of manure or compost that is incompletely rotted, and prolonged periods of warmth with high humidity.

BACTERIAL ROT OF LETTUCE

Symptoms—The marked symptoms of this disease are the numerous spots on the leaves which at first have a water-soaked appearance. As these spots increase in size they fuse to form large blotches which eventually spread over the entire leaf. Such leaves turn brown and rot, sometimes with a soft, wet rot and sometimes with a dry rot and shrivelled leaves. The heart of the lettuce may be sound while the outer leaves are soft-rotted or shrivelled and dry, and the leaves between more or less affected.

Cause—This disease is caused by the bacterial organism, *Phytophthora vitivivida* (Brown), Bergey et al.

Control—Levine found that spraying with formalin, one pint to thirty gallons of water, would check the disease.

MARGINAL LEAF BLIGHT OF LETTUCE

• *Symptoms*—The chief symptoms of this disease are the brownish, dry and papery margins of affected leaves, which accounts for this trouble being mistaken for Tip-burn. The edges affected first show a slight marginal wilting, then turn brown or blackish over an area almost a quarter

of an inch in depth along the entire edge of the blade. If the season is dry the margin of the leaf may fall away leaving a jagged edge.

Cause—*Phytophthora marginale* (Brown) Bergey et al, is the bacterial organism which causes this disease. The bacteria enter the plant through the breathing pores of the leaf (stomata) during periods of high humidity, cold, or when plants are excessively watered.

Control—Subirrigation instead of overhead watering is a safeguard. Under glass good ventilation will almost, if not entirely, prevent the disease.

BACTERIAL WILT OF LETTUCE

Symptoms—The chief symptom of this disease is a wilting of the plant. In the early stages of the disease the infected plants are lighter green in colour than healthy ones. The oldest leaves are usually affected first. This is followed by infection of the younger leaves, stems and roots, or the stem may be diseased while the leaves remain apparently healthy. Brown spots may occur on the leaves which at first are definitely outlined, but later these coalesce to form darkened blotches. Diseased plants are not firm in the ground because the roots are diseased. In some instances wilting of the whole plant may take place without any spots appearing on the leaves.

Cause—This disease is caused by the bacterial organism *Phytophthora vitians* (Brown) Bergey et al.

Control—Use thoroughly decomposed compost or well rotted stable manure.

TIP-BURN OF LETTUCE

This is one of the most destructive diseases with which lettuce growers have to contend. It usually does most damage in seasons when the crop develops so rapidly that it is impossible to cut it all just at the right time.

Symptoms—The symptoms are very characteristic. On affected plants the edges of the leaves die and turn brown thus making the lettuce unsightly and hence not readily saleable. In severe cases the growth of the plant is interfered with. Hard headed varieties of lettuce are usually more susceptible to tip-burn than the loose heading and leafy varieties.

Cause—It is generally conceded that tip-burn is caused by weather conditions, chief of which is high temperature. Formerly it was thought to be brought about by two or three warm days resulting in soft watery growth followed by a warm bright day with rapid evaporation, but it has been shown that tip-burn can originate even in the dark and it is now thought that the degeneration of the cells at the tips of the leaves is due to faulty respiration, which is brought about by high temperature.

Control—Little exact information is available concerning the control of this disease. Lettuce grown under glass should not be overwatered and the house should be well ventilated and kept comparatively cool. In the field when the soil is packed by heavy rains deep and frequent cultivation is recommended. Big Boston head lettuce is very susceptible to tip-burn. In experiments conducted in the United States the sparing use of potash and medium applications of phosphate have reduced the amount of tip-burn in some fields.

ONIONS

ONION SMUT

This is the most destructive disease of onions. It has become prevalent and very destructive in several of the important onion growing districts in Ontario.

Symptoms—Smut develops only on onions that are grown from seed in soil containing smut spores. It frequently destroys large numbers of the seedlings soon after they appear above the ground. The leaves of affected seedlings become curled and twisted, and dark streaks show within the tissues. These streaks are filled with a dark brown powdery mass. Diseased seedlings that are not killed in the early stages often die later or produce small, distorted bulbs with black streaks. If these black streaks are broken open they are found to be filled with a black mass of smut spores.

Cause—Onion Smut is caused by the fungus *Urocystis cepulae* Frost. This is a soil organism that may live in the ground for many years. It can infect onions only for a brief time during the development of the seedlings. The period of infection extends from the time of germination until the seedlings are in the first leaf. This is usually about two weeks. Once the seedlings have passed this stage the fungus cannot infect them. The spores of the fungus are carried from place to place on onion sets, by running water or in the soil adhering to implements, the feet of men and animals and the roots of other vegetables.

Control—A formalin solution applied when the onion seed is being sown has given excellent results in the control of this disease. The formalin is applied by means of a tank and drip attachment on the onion seeder. Numerous experiments have been conducted in the Pelee marshes on muck soil and the best results have been obtained from the following solutions: (1) Formalin, one pint to fifteen gallons of water, applied at the rate of 150 gallons per acre; (2) Formalin, one pint to ten gallons of water, applied at the rate of 100 gallons per acre. The latter solution cuts down to a minimum the amount of water that must be used and thus reduces the labour to a considerable extent. This is an important factor. Loam soils do not require as much liquid as muck soils.

The formalin method for smut control is now extensively used by commercial onion growers and it is the only satisfactory treatment when large quantities of onions are grown. Those who wish to grow a few onions in soil containing smut may do so by sowing the seed in smut-free soil and then transplanting the onions after they have passed the susceptible stage. Onion sets may be planted in soil containing smut and not develop the disease, that is, provided the seed from which they were grown was sown in smut-free soil. Sets grown from seed in smutty soil is one of the methods of distributing the disease.

ONION BLIGHT OR DOWNY MILDEW

This is a very common disease of the onion in Ontario, and in some parts of the Province it frequently decreases very materially the onion crop by destroying the leaves and thus reducing to a marked extent the size of the bulbs.

Symptoms—The disease is usually first noticed in late June or July. Affected leaves show peculiar violet-tinted areas which are due to the fuzzy spore-bearing portions of the fungus on the surface. They very soon

become pale or yellowish in spots, collapse and break down. In severe attacks all the leaves are soon destroyed. Often a new crop of leaves develops and these also may be destroyed by the disease. From this second attack the onions seldom recover.

Cause—This disease is caused by the fungus *Peronospora schleideni* Unger. Two kinds of spores are produced by this fungus, namely, thin-walled summer spores borne on the minute, branched spore-bearing part of the fungus covering the surface of the attacked leaves, and thick-walled resting spores (oospores) formed in the tissues of the dead leaves. The summer spores are freely scattered by wind during the summer and new leaves become infected. In this way the disease is spread very rapidly, especially during damp, muggy weather. Dead leaves containing the thick-walled resting spores lie on the ground during the winter and in the spring these spores germinate and give rise to the disease if onions are planted on the same ground again. The fungus also lives over as dormant fungus threads (mycelium) in the onion bulbs and sets.

Control—Rake up and burn the diseased tops as by so doing many of the resting spores will be destroyed. If possible practice a rotation of crops as the fungus is carried over the winter by the resting spores in the soil, and it is believed that they retain their vitality for two or three years. The choice of land for the growing of onions is important. The soil should be well drained and wind barriers such as woods, hills, fences and weeds should be avoided as far as possible, so that there will be a free circulation of air over the field which will dry the plants quickly after rain and heavy dew. When growing onions from sets or planting seed bulbs it is important that these should not be taken from fields where onion blight has been prevalent. Spraying with Bordeaux with a sticker has been recommended by some American authorities. At best it is a difficult task and so far there is not experimental evidence to show that it is profitable here in Ontario. However, in those sections of the Province where onion blight causes serious loss nearly every year, spraying in conjunction with the other methods of control should be given a fair trial. Spray with Bordeaux mixture, four pounds bluestone, five pounds hydrated lime and forty gallons of water. To this mixture add three pounds of resin fish oil soap as a sticker. The spraying should be started if the weather becomes wet towards the end of June and an application made at least once a week if it is a wet season. In order to avoid destroying the onion plants the sprayer (if a power outfit) should be equipped with a very long boom and many nozzles, or with two or more leads of hose so that a man at the end of each hose may spray three or four or more rows at a time.

ONION SMUDGE

This is a disease that is common in Ontario. In wet seasons it seriously disfigures white onions. It does little or no harm to yellow or red onions.

Symptoms—The most pronounced symptom is the dark green or black smudge on the bulb or neck of the onion. Sometimes the surface of the smudge spots is uniformly black. Frequently, however, the black smudging is in concentric circles. The smudging may be so extensive as to cover the greater portion of the bulb and disfigure it very badly. In severe cases the fungus grows through the outer scales into the living tissue below, causing collapse of the fleshy scales. The disease may appear at any time in the life of the onion plant in storage or during transportation as well

as in the field. Sometimes it causes a damping off of the seedlings. This symptom of the disease has not been observed in Ontario.

Cause—This disease is caused by the fungus *Colletotrichum circizans* (Berk.) Vogl. This fungus passes the winter on onions, on sets and in the soil. It is only under the most favourable conditions of moisture and temperature that it can attack growing onions and cause disease. It is carried long distances on bulbs and sets, and possibly on the seed. Most of the infection takes place in the field. This fungus develops best in relatively high temperatures (75 to 80° F.) and requires relatively high soil moisture. It causes most damage when we have hot damp weather shortly before harvest time.

Control—No entirely satisfactory control measures are known. Careful harvesting of the bulbs and thorough drying before placing in storage help to reduce the injury caused by this disease. Practicing a rotation of crops so that white onions are not grown on the same piece of land oftener than once in every three or four years should reduce the loss from this trouble. This disease can be avoided by growing the resistant coloured onions in place of the white or silver-skinned varieties.

PEAS

ROOT ROT AND BLIGHT

In the eastern section of Ontario, especially in Prince Edward County and adjacent mainland, this disease has been a serious handicap for many years. Some men have been forced to give up pea growing or to abandon the crop for several years. In many cases, tenants have suffered heavy losses through sowing peas on "pea sick" soil.

Dr. R. E. Stone, of the Botanical Department, has made a special study of this disease and the following account of it is based on his observations and experiments.

Symptoms—The disease generally becomes noticeable just about the time the peas are coming into bloom, although in severe cases it may be noticed earlier than this. Frequently large patches in fields or even whole fields of peas will dry up and produce little or no seed. First the lower leaves turn white or grey and in a few days or a week the plants wilt down. The roots of such plants are usually brown and rotten. The outer layers, or cortex, slough off readily and the little feeding roots are all destroyed. On the stem, just at the surface of the ground, there is generally a blackened area. The whole top of the plant takes on a dry, greyish colour.

Cause—This disease appears to be caused by at least two fungi growing on the roots, a species of *Fusarium* and *Aphanomyces euteiches*, Dreschler. These are soil fungi, that is, they are capable of living in the soil for a considerable period of time.

Control—First, crop rotation; second, the use of resistant varieties. If the disease has been serious, a rotation of crops should be followed in which peas are not grown in the field oftener than once in five years.

Resistant varieties. Experiments carried on over a number of years have shown that the following varieties of peas are resistant to root rot and blight and can be grown safely in infested soil: Alcross, Alderman, Champion of England, Green Admiral, Green Feast (Lincoln), Improved Advancer, Horal, Prince of Wales, Quite Content, Rice's 330, Telephone, Yellow Admiral.

The following varieties are susceptible and cannot be grown in infested fields: American Wonder, Alaska, Earliest of All, Gradus, Horsford, Improved Stratagem, Laxtonian, Laxton's Progress, Little Marvel, Nott's Excelsior, Onward, Peter Pan, Roger's Winner, Sutton's Aquisition, Thomas Laxton.

BLIGHT, LEAF SPOT OR POD SPOT OF PEAS

This disease is commonly seen in Ontario but seldom causes enough injury to attract attention.

Symptoms—Stems, leaves, pods and seeds are affected. Stems of infected plants show discoloured areas of dead tissue, sometimes extending completely around them, destroying the shoot. Diseased leaves show circular or oval discoloured spots from one-eighth to one-half inch in diameter. On the pods light coloured, sunken spots develop much like those of bean anthracnose.

Cause—This disease is caused by the fungus *Mycosphaerella pinodes* (Berk. and Blox.) Stone. This fungus passes the winter chiefly as dormant fungus threads (mycelium) in the seeds.

Control—So far it has not been necessary to practice any particular control measures in Ontario. If it should become serious it can be checked by the following measures: Sow non-infected seed. If only a small amount of seed is necessary, disease free seed can be obtained by selecting it from healthy pods. Large quantities of non-infected seed can be secured from seed growers in the dry regions of the West. Grow peas on well drained soil and practice a rotation of crops. Do not use pea straw or other pea refuse as a fertilizer on fields where peas are to be grown. No varieties of peas are immune but Horal and Champion of England are very resistant to this disease as well as to Root Rot and Blight.

BACTERIAL WILT OR STEM BLIGHT OF FIELD AND GARDEN PEAS

Symptoms—This disease can be recognized readily by watery, olive-green to olive-brown spots and streaks on stems, petioles, leaves, stipules and pods. When the disease makes its appearance early in the season, before the plants are more than three to four inches high, one usually finds a very uneven stand with several feet of the rows without a plant, but on close examination of the ground one will find the brown withered remains of the plants. Stem spots are more linear than the water-soaked spots on the leaves, and sometimes the whole stem turns dark green and finally brown. Infection may spread through the flower stalk, killing the flower and causing the young pods to shrivel and decay. Older pods show water-soaked spots and cracking, and from these spots the seeds inside become infected and covered with bacterial slime, which may remain on the surface or may penetrate the seed coat. The bacteria may break down the tissue to produce large cavities, and if they enter the veins wilting of the plant results.

Cause—This disease is caused by the bacterium *Phytophthora pisi* (Sackett) Bergey et al, which is carried over on the seed and in the soil, and enters the plant through the breathing pores (stomata) or through wounds.

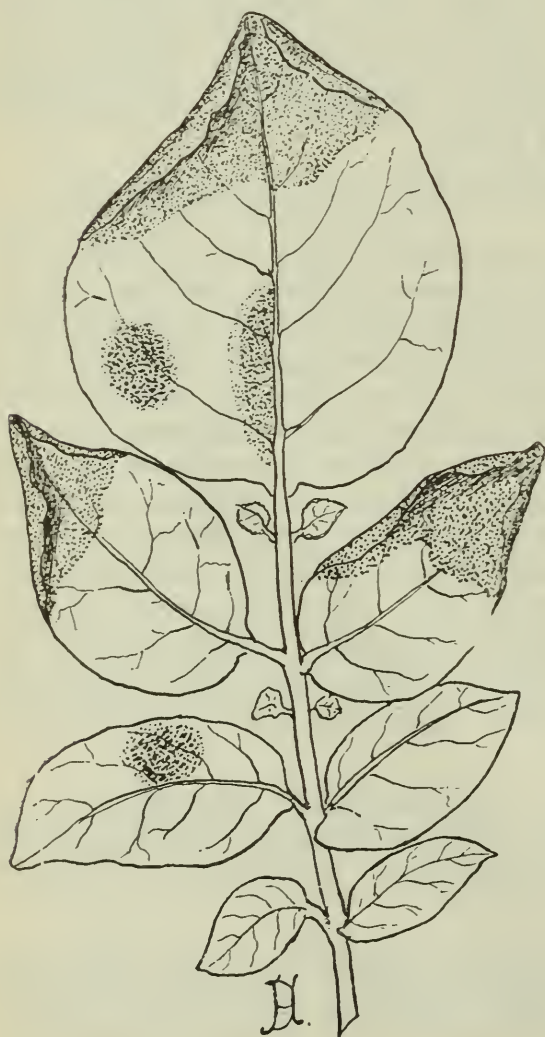
Control—As the organism is seed borne, endeavour to use seed from crops which are known to be free from the disease. Practice a rotation of crops so that peas are not grown on the same soil oftener than once in three or four years.

POTATOES

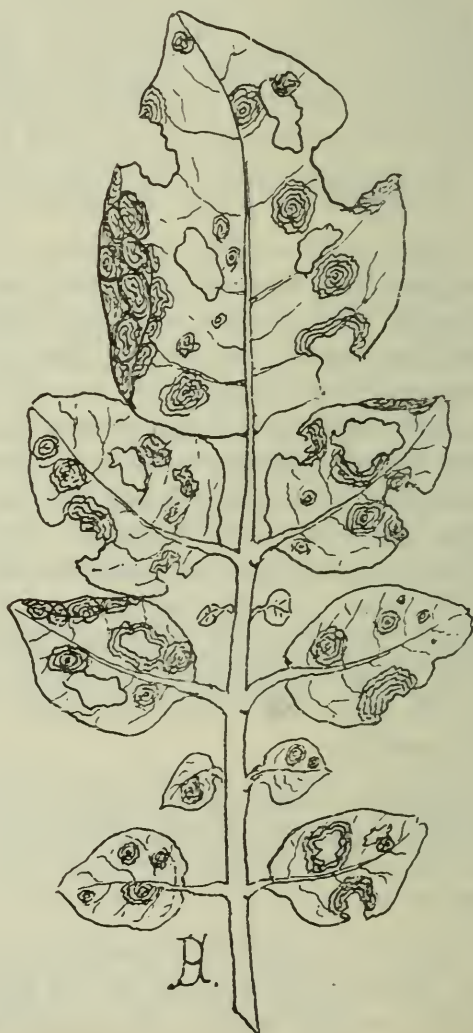
LATE BLIGHT AND ROT OF POTATOES

This is the most destructive disease of potatoes in the Province. In wet seasons it frequently destroys a large proportion of the crop. The effects of the disease are not noticed usually until late summer—August or September. Occasionally, however, if the weather is wet about the middle of July the disease may be observed in the fields by the middle or end of the month. It is always worse on low lands and on the heavier types of soils.

Symptoms—This disease, as the name implies, causes a blighting of the leaves and a rotting of the tubers. The blight is seen usually first on the margins of the lower leaves. Irregular dark spots or blotches are observed. These have a water-soaked appearance when held up to the light. On the under surface of these blotches especially around the margin a delicate white fungus growth may frequently be seen. In wet weather the blotches enlarge rapidly and the whole leaf is involved, becomes soft, brown, rotten and droops. In this way all the tops may be destroyed in a few days. If dry weather checks the development of the disease the spots do not enlarge but become dry, brittle and brown. On some of the infected tubers pits or more or less depressed areas are seen. Sometimes these have a somewhat purplish or reddish tinge and a water-soaked appearance. If the diseased potatoes are cut, a rusty brown dry rot is seen in the flesh



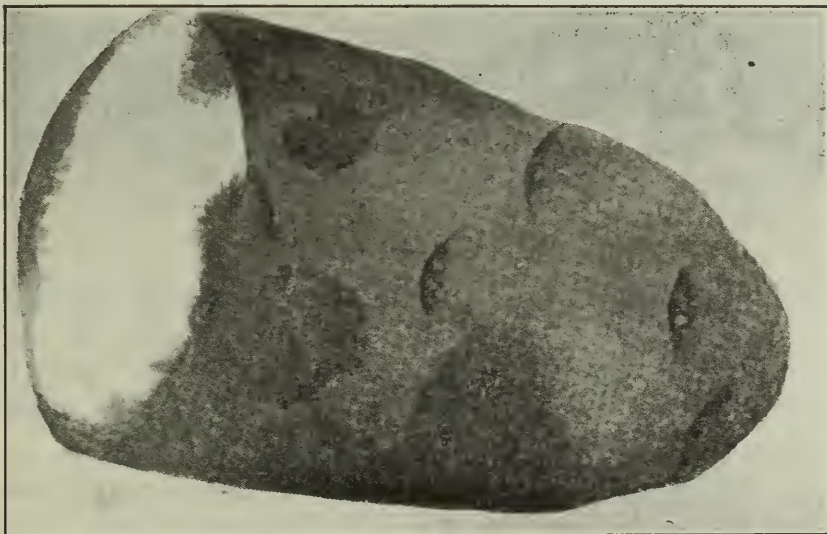
Late Blight.



Early Blight.

just beneath the skin. Infected tubers dry rot in the field or in storage. Tubers when dug may show no signs of rot, but if they have been produced by blighted plants the rot is very likely to develop in about three weeks after they are placed in storage. A wet soft rot often develops in wet seasons. This is frequently seen when the potatoes are dug and is due to secondary organisms which gain entrance to the tubers through the dead areas produced by the fungus which causes the Late Blight and Rot.

Cause—Late Blight and Rot is caused by the fungus *Phytophthora infestans* (Mont.) De Bary. This fungus is rapidly spread through the crop during wet weather by means of numerous spores produced on the lower surface of the affected leaves and scattered by rain, wind and insects. Some of these spores are washed off the leaves down through the soil on to the tubers which they are able to infect. Tubers are also often infected by coming in contact with blighted tops and contaminated surface soil when they are being dug. The fungus is carried over the winter chiefly as fungus threads (mycelium) within infected tubers. Slightly infected tubers show little or no external evidence of the disease. When infected tubers are used for seed the fungus threads in them may develop and produce spores on the surface of the seed pieces, or the fungus threads may grow up into the sprouts and produce spores on the outer surface of the growing shoots. The spores produced on the seed pieces or on the developing shoots may be washed or splashed by rain to the leaves which they are able to infect. These infected leaves soon develop blight. There is also some evidence to indicate that the fungus may be carried over as resting spores in the diseased tops. This, however, has not been demonstrated in Ontario. The conditions which favour the development of this fungus are excessive moisture, cool nights and warm days.



Characteristic Rot due to the Late Blight and Rot fungus.
(After Gussow)

Control—Spraying with Bordeaux mixture is the most reliable means of preventing Late Blight and Rot. Commence spraying when the potato beetle eggs are just hatching, which will usually be when the potato plants are from five to eight inches high, and keep the foliage covered with Bordeaux throughout the season, taking special precautions to see that it is well covered during wet weather. Do not put off spraying because it looks like rain for once dry the spray mixture will remain on the leaves and be

on at the critical time. This statement will be understood when it is realized that infection takes place during or immediately after rain. For the first application use Bordeaux mixture (formula four pounds copper sulphate, five pounds hydrated lime and forty gallons of water). Add two pounds of arsenate of lime (calcium arsenate) to each forty gallons. Repeat the spraying often enough to keep the foliage well covered. Add the arsenate of lime to the Bordeaux only when required for potato beetles. No stated number of sprayings with the Bordeaux can be recommended; the number depends on the weather—the wetter the weather the larger the number. Four to seven sprayings are often necessary. If the season is favourable for Blight and Rot continue the spraying until the plants have finished their growth and died or have been destroyed by frost. It is very important to use plenty of Bordeaux at each application. Forty gallons may be sufficient to cover an acre of potatoes when the plants are small but when the plants are large from eighty to one hundred gallons or more may be required for each acre. The best results are obtained by applying the Bordeaux under high pressure in the form of a fine mist so as to cover both surfaces of the leaves. High pressure power sprayers which deliver plenty of the Bordeaux to cover thoroughly the vines are the most satisfactory machines for spraying.

Dusting is sometimes practised instead of spraying. Copper-lime dust is used. On the whole the results from dusting have not been as satisfactory as those from spraying. Some growers, however, prefer dusting to spraying because it requires less time. The best results from dusting are obtained from frequent and heavy applications of the copper-lime dust.

Other means which can be used to lessen loss from this disease: Plant the more rot resistant varieties of potatoes (see O.A.C. bulletin 239). Avoid soils that are not thoroughly underdrained either naturally or artificially. Plant certified seed potatoes. These are potatoes known to be comparatively free from disease. When the vines are blighted allow them to die and become thoroughly dry before digging the potatoes. Remove the potatoes from the field as soon after digging as possible. Sort them carefully and store in a cool, dry cellar, spreading out as thinly as possible. The proper temperature for storage is about 38° F.

EARLY BLIGHT

This disease is common and in some years causes noticeable damage. It sometimes appears when the plants are small but it is most abundant about the time the potatoes are in blossom. In severe cases the foliage is badly damaged and the tubers remain small. Unhealthy plants and those attacked by the flea beetle suffer most from this disease.

Symptoms—Small, scattered, greyish-brown circular spots are first observed on the leaves. These take on a minutely velvety appearance and gradually become larger. Sometimes they run into one another until in some cases half the leaf may become brown and curled. As the spots enlarge faint concentric rings appear on them described as “target brand” markings. Leaves which are very badly spotted often turn sickly yellow in colour.

Cause—The causal fungus is *Macrosporium solani* E & M. This fungus is carried over the winter by means of spores in the soil and by fungus threads in diseased potato tops and weeds.

Control—Spray with Bordeaux mixture as directed for Late Blight and Rot. Take special care to see that the early applications are very

thoroughly applied. A three to five year rotation of crops will also help control this disease. Weeds closely related to the potato such as nightshade and ground cherry should be destroyed as they harbour the causal fungus.

COMMON SCAB

This scab is familiar to nearly every potato grower. It is, however, not confined to the potato but is sometimes seen on garden beets, sugar beets, turnips and radishes.

Symptoms—It is easily recognized by the roughened corky spots on the skin of the tubers. These may be few and scattered or numerous and close together so as to disfigure the potatoes badly. Sometimes there are also blackened pocket-like cavities. Scab does not injure the flesh of the tubers to any great extent but it renders them unsightly and hence not readily saleable when potatoes are plentiful.

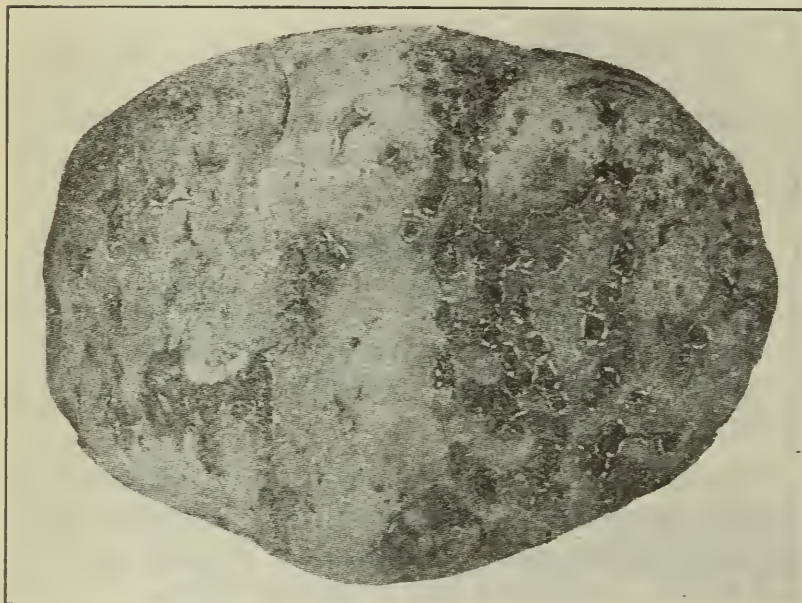
Cause—Common scab is caused by one of the higher bacteria known as *Actinomyces scabies* (Thax.) Gussow. This organism is carried over the winter on seed potatoes and in the soil. It remains in the soil for several years after a crop of scabby potatoes has been produced. It will also pass through the intestines of stock fed on scabby potatoes. This organism appears to be native to some soils. A few scabby potatoes in a bag may contaminate the whole lot. It thrives best in an alkali soil and is checked by acidity. It develops most readily in a soil rich in organic matter and at a comparatively high temperature.

Control—This disease can be controlled only by combining seed treatment with cultural practices. Seed treatment alone cannot be relied upon. Its chief purpose is to prevent the introduction of the scab organism into non-infected soils. It will not appreciably reduce the amount of scab in soils in which the scab organism is abundant. The cultural practices which can be employed to control potato scab are as follow: Use seed potatoes free from scab. Practise a definite rotation of crops in order to starve out the organism in soils heavily infested with scab. Beets, mangels and turnips should not be grown in such a rotation as they serve as carriers for the scab organism from season to season. Under normal conditions practise a rotation of from three to five years between potato crops. If the soil is very heavily infested with the scab organism it may be necessary to follow a five to six year rotation. Grasses, small grains, alfalfa or clover, constitute excellent crops for such rotations. Plant potatoes immediately following clover, alfalfa and other leguminous crops. Be careful in the use of fertilizers. Lime, wood ashes and fresh stable manure should not be applied to soils intended for potatoes on account of their alkaline nature. *A suitable fertilizer for scab infested soils consists of 267 pounds nitrate of soda, 200 pounds sulphate of ammonia, 1000 pounds 16 per cent. super phosphate, 333 pounds sulphate of potash magnesia, 200 pounds muriate of potash which is equal to a ton of 4-8-10 mixture. This should be applied at the rate of 500 pounds to 1000 pounds per acre on normally good potato soil. Never feed potatoes infected with scab and peelings from same to stock unless they have been boiled. Treat seed potatoes with formalin or mercuric chloride. (See pages 42 and 43.)

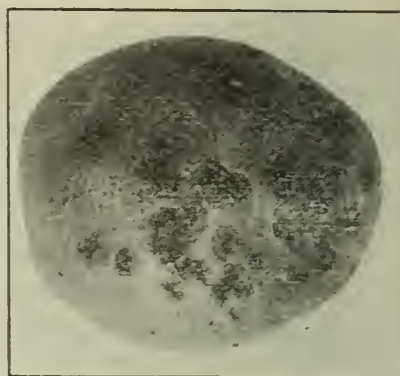
*Recommendations regarding fertilizer made by Professor Bell, Ontario Agricultural College, Guelph.

POWDERY SCAB

This disease was first reported as occurring in Canada about 1912. It was found in Prince Edward Island, Nova Scotia, New Brunswick,



Powdery Scab (after Morse).



Common Scab. (Original.)

Quebec and Alberta. In 1914 it was reported from Northern Ontario. It does not seem to be established in the southern parts of the Province. It does not appear to cause serious trouble in warm, comparatively dry soils.

Symptoms—Tubers infected by the Powdery Scab fungus become covered with conspicuous scab spots which are more clearly defined, more elevated and smoother on the surface than Common Potato Scab. When the skin of the scab spot is broken the cavity beneath is seen to be filled with a brownish or greenish powder. The chief injury is the unsightly appearance of the tubers. In very severe cases, however, the potatoes may be stunted and malformed and there is always a greater tendency for infected tubers to shrivel and dry rot in storage.

Cause—The cause of Powdery Scab is a slime mould known as *Spongospora subterranea* (Wallroth) Johnson. This fungus is spread mainly on seed potatoes. It is introduced into new localities chiefly through planting "seed" which is infected or which has come in contact with infected tubers or with bags, crates, implements, etc., which have been used in handling them. Once the fungus gains entrance to a soil it will apparently remain there for a number of years. It develops best in wet cool soils and it will not develop in warm, comparatively dry soils.

Control—Secure seed potatoes from a district known to be free from Powdery Scab. Plant only sound tubers free from scab and as a precaution disinfect them with either corrosive sublimate or formalin. (See directions pages 42, 43.) Good drainage and a long rotation of crops will also aid in the control of this disease.

RHIZOCTONIA OR BLACK SCURF

This disease is very frequently met with in Ontario, and in seasons of excessive rainfall often results in a noticeable reduction of the crop. It does more damage in Northern Ontario than it does in the southern parts of the Province.

Symptoms—Tubers are very frequently seen with what appear to be lumps of hardened soil adhering to them. These are black in colour when wet. They vary in size from mere specks to one-quarter of an inch in diameter. Sometimes they are very numerous and quite noticeable. They are known as sclerotia and consist of compact masses of resting fungus threads (mycelium). The skin of the potato beneath them is often roughened and russeted but the flesh of the tuber is not injured to any appreciable extent. If potatoes, however, with these sclerotia adhering to them are planted the fungus may spread into the developing sprouts and kill them before they get above the ground. This is one cause of “misses” in the rows. Later in the season several other symptoms may develop. Young shoots may wither and die and if they are pulled up and examined there will be found near the base of the stems brown dead areas often encircling them. Sometimes large plants become sickly yellow and develop many fine spindly shoots. Such plants also show dead brown areas near the base of the stems and on the underground parts. Occasionally at the base of the stems of affected plants clusters of small tubers may be found and quite frequently small greenish potatoes are seen on the stem above the ground. Such aerial tubers are very characteristic of the disease but they may result from other causes such as injury to the stem by cultivation.

Cause—This disease is caused by the fungus *Corticium vagum* B. and C. This fungus attacks many plants besides the potato. Among the more important hosts of this fungus are carrots, beets, beans, cabbage, parsnips, onions, turnips, peas, celery, rhubarb, spinach and lettuce. The fungus lives over winter in the soil and on the tubers in the form of fungus threads (mycelium) and sclerotia. It is probable that few soils are free from it.

Control—Dig the potatoes as soon after they are mature as possible. The longer they are in the soil, especially in a wet fall, the greater the chances of sclerotia developing on them. Select seed potatoes as free as possible from little, black, hard lumps (sclerotia) on the surface and disinfect them, before they are cut for planting, with corrosive sublimate or acid corrosive sublimate. See directions on page 42. This treatment should be done when the potatoes are dormant, that is, before the buds in the eyes begin to grow.



Hard black lumps (sclerotia) of *Rhizoctonia* on Potato.
(Original.)

METHODS OF DISINFECTING SEED POTATOES

Disinfecting seed potatoes helps in the control of such diseases as Blackleg, Common Scab, Black Scurf or *Rhizoctonia* and Powdery Scab. They should always be treated before they are cut and if possible before they have started to sprout, as the treatment destroys the sprouts and thus retards the growth.

A convenient method for handling potatoes when treating them is to place wooden barrels on a sloping elevated platform in such a manner that the solution used for treatment can be drained off from the bottom of one barrel before removing the potatoes, and added to another barrel.

All bags and crates that will be used to handle treated potatoes should be disinfected also with formalin (one pint to thirty gallons of water) or corrosive sublimate (mercuric chloride) but not with any liquid containing acid as the acid will destroy them. Corrosive sublimate corrodes metal and hence should be handled in wooden or earthen containers. It is also very poisonous, and bags disinfected with it should not be used to hold potatoes intended for food unless they have been well washed in water to remove any of the poison that may adhere to them.

There are many methods of disinfecting seed potatoes. Four of the most effective are described below.

THE ACID CORROSIVE SUBLIMATE TREATMENT

(This treatment is recommended for the control of Black Scurf or Rhizoctonia, Blackleg, Common and Powdery Scab)

It consists of dipping the seed potatoes before they are cut, for ten minutes, in a solution made by stirring four ounces of corrosive sublimate (mercuric chloride) in two pints of commercial hydrochloric acid and diluting to twenty-five gallons with water. This solution may safely be used for ten treatments, and if the duration of dipping is increased to fifteen minutes for a further five. The potatoes should be immersed unbagged, and afterwards dried. The treatment may be carried out some months before planting. This is a cheap and effective method.

N.B.—If this treatment is used, be sure to dry the potatoes immediately afterwards. Corrosive sublimate is a deadly poison and should be kept out of the way of children and stock. Potatoes disinfected with it should never be used for food for man or beast. It corrodes metal and should be handled in wooden or earthen vessels.

CORROSIVE SUBLIMATE TREATMENT

(This treatment is recommended for the control of Black Scurf or Rhizoctonia, Blackleg, Common and Powdery Scab.)

If a large tank or trough is available, soak the seed potatoes in clean water for five to ten hours. If no large tank is available place the potatoes to be treated in a pile on the barn floor, sprinkle them thoroughly with water and cover them with wet sacks, and leave for twelve hours. At the end of this time soak them for an hour and a half in a solution of corrosive sublimate of the strength of four ounces of corrosive sublimate in twenty-five gallons of water. In preparing this solution, dissolve the corrosive sublimate in a little hot water, then add it to twenty-five gallons of cold water. Fill a barrel or trough with the potatoes, then add the solution until the potatoes are covered. Leave for the required time, then drain off

the solution into another receptacle. After each lot of tubers has been treated, add half an ounce of corrosive sublimate and keep the volume of the solution constant by adding more water when necessary. After four lots of tubers have been treated the solution should be entirely renewed.

FORMALIN OR FORMALDEHYDE TREATMENT

(This treatment is recommended for the control of Common Scab only.)

Soak the seed potatoes before they are cut for two hours in a solution, made by adding one pint of commercial formalin to thirty gallons of water. The same formalin solution can be used to treat successive lots of potatoes. Thirty gallons of water is sufficient to treat from forty to fifty bushels if ordinary precautions are taken not to waste the solution when dipping. If the potatoes are not all disinfected on the same day, it is advisable to make up a fresh supply of formalin for each day's treatment. Formalin does not affect metal hence galvanized or tin pails may be used.

HOT FORMALDEHYDE TREATMENT

(This treatment is recommended for the control of Common Scab and Black Scurf or Rhizoctonia.)

A formalin solution consisting of two pints of formalin in twenty-five gallons of water should be kept at temperatures ranging from 120° to 126° F. and the potatoes to be treated should be soaked in this solution for three minutes. After immersion the tubers should be placed in a pile and covered with blankets, bags or other covers for at least an hour in order to retain the volatile formaldehyde around the tubers. After the covers are removed the tubers should be allowed to dry thoroughly. It is also important to disinfect all bags and crates that are used in handling the disinfected potatoes. Seed disinfection should be done when the tubers are dormant or nearly so. It can be done in the fall, or in the spring immediately before planting.



Fusarium Dry Rot of Potatoes. (Original.)

FUSARIUM DRY ROT

This rot frequently develops in potatoes in storage late in the winter or early spring.

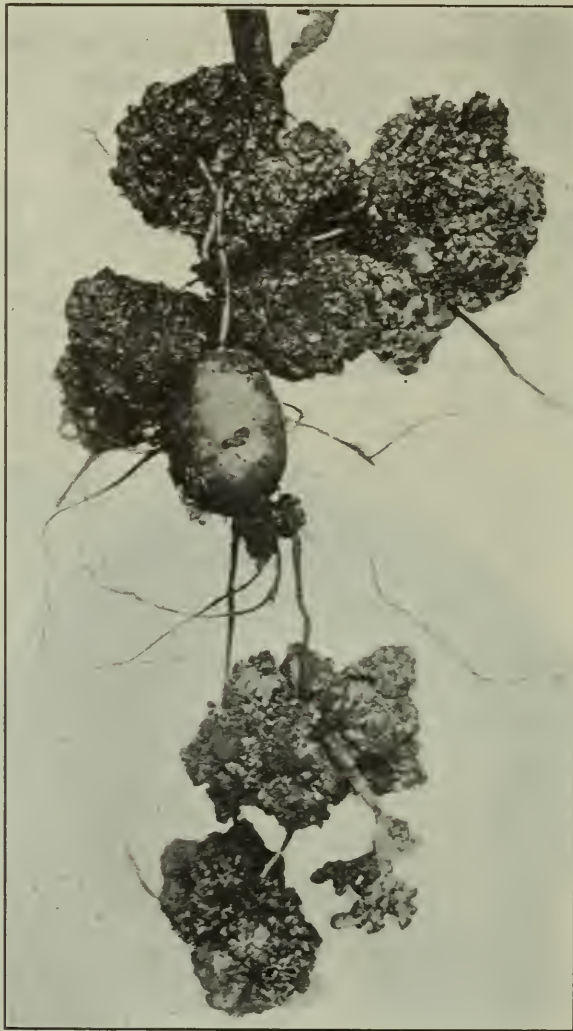
Symptoms—A firm, cheesy, dry rot develops in the tubers. This is often confined more or less to one end of the potato. The surface of the rotten portion is often covered with a white or pinkish fungus growth. Sometimes the whole potato shrivels and dries to a hard mass.

Cause—Various species of *Fusarium* are the chief cause of this trouble. Some of these gain entrance to the tuber if the skin is broken when the potatoes are being harvested, transported or stored.

Control—Handle the potatoes in such a way as to eliminate bruising as much as possible.

POTATO CANKER OR WART DISEASE OF POTATOES

This disease was found in Canada in 1912, but is not found in this country at the present time. This is owing to the fact that at its first appearance very prompt measures were taken to stamp it out, and prob-



Potato Canker. (After Gussow.)

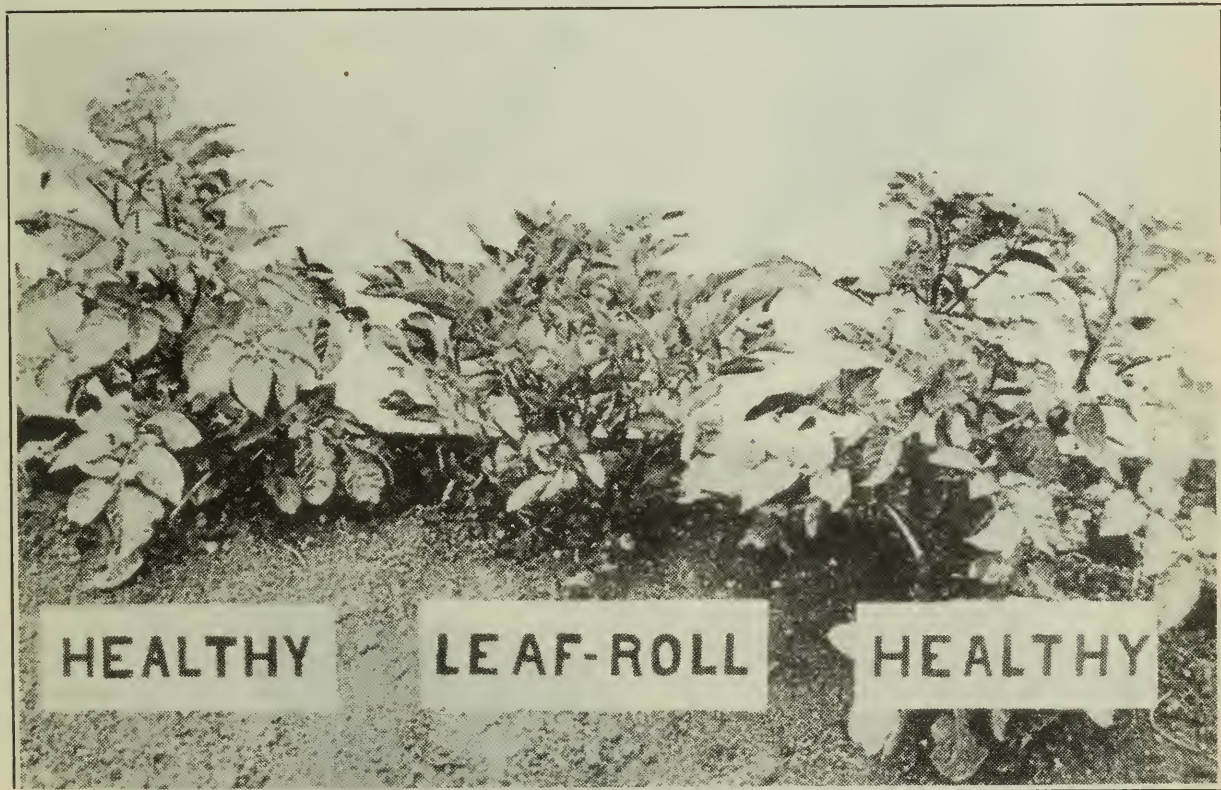
ably to some extent to the fact that the two commercial varieties of potatoes which are so extensively grown in Ontario, namely, Green Mountain and Irish Cobbler, are immune to this disease. It is a very serious disease to susceptible varieties of potatoes, and it is important therefore that

Ontario growers should be able to recognize it in order that they may report its presence promptly should it at any time appear in their crop.

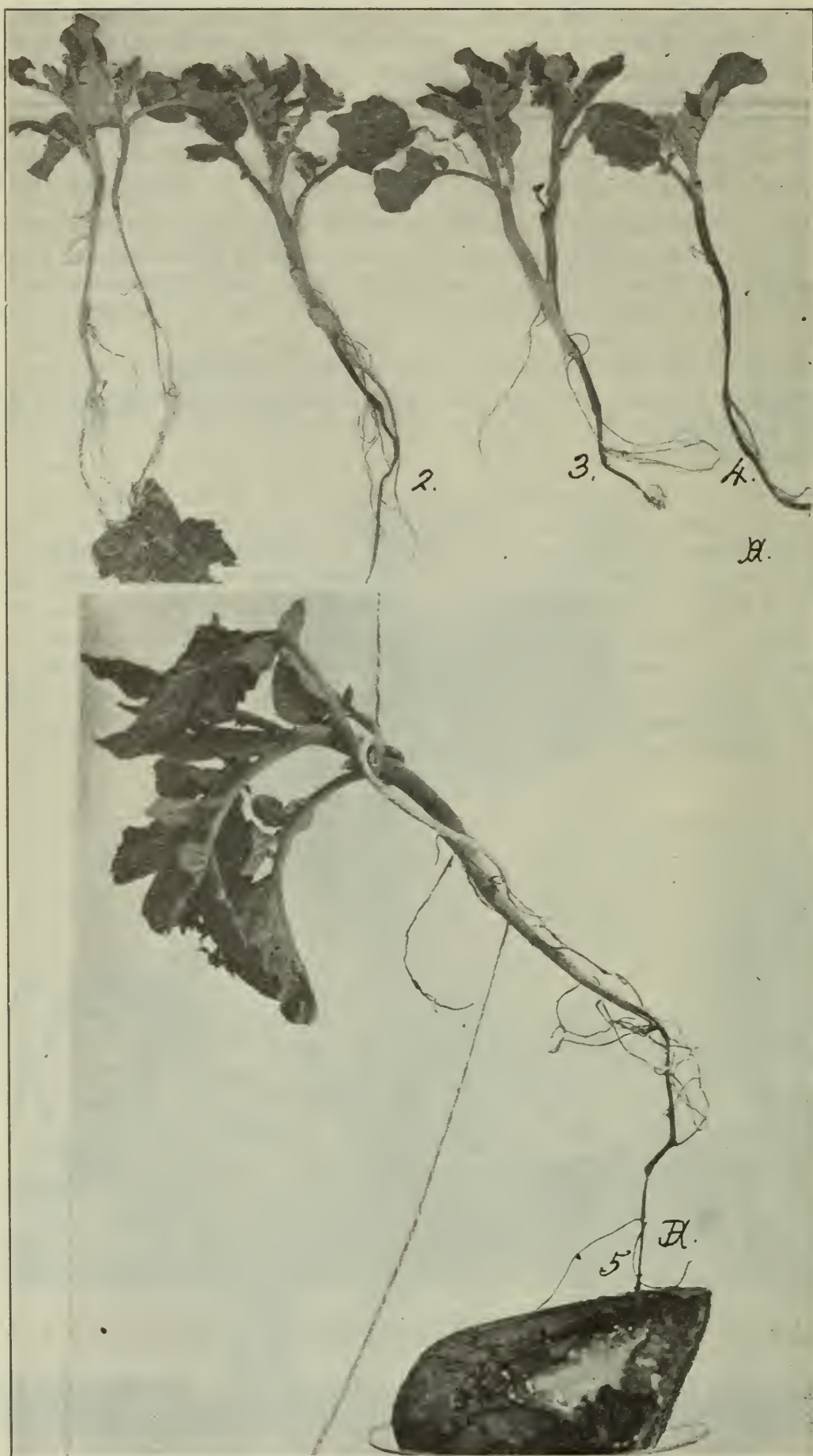
Symptoms—Potato Canker is not usually observed until harvest time. Badly affected tubers are simply brownish-black masses of warty excrescences not in the least resembling potatoes. Tubers showing the early stages of the disease have some of the eyes slightly protruding and composed of simple or compound groups of small brown nodules. In the early stages this disease is very likely to be overlooked by the casual observer.

Cause—This disease is caused by the fungus *Synchytrium endobioticum* (Schilb) Perc. This organism is carried over from season to season in the soil or in tubers. It may be carried into clean soil by drainage from infested soil, by farm implements and on the feet of men and animals. Planting infected tubers or tubers which have come in contact with diseased tubers is another way by which this organism is spread. It is also spread in manure from animals to which diseased potatoes have been fed and by garbage into which warts or peelings from diseased tubers have been thrown.

Control—Grow varieties of potatoes known to be immune to Potato Canker. In tests conducted in the United States the following varieties have been found to be immune: Green Mountain, Irish Cobbler, Early Petoskey, Peach Blow, McCormack and Burbank. Among those valuable varieties which were found to be very susceptible to Potato Canker are: Rural New Yorker, Early Rose and American Giant. If susceptible varieties of potatoes are grown be on the watch for this disease and if suspected potatoes are found send samples to the Dominion Botanist, Central Experimental Farm, Ottawa, or to the Botanical Department, Ontario Agricultural College, Guelph.



Plant in middle showing typical Leaf Roll. A healthy plant on either side for comparison.



Black Leg of Potato.

LEAF ROLL

In the past this disease has been very prevalent in the potato growing districts of Old Ontario. Since the use of certified seed potatoes has become general, very much less leaf roll is seen in the Province. This disease may reduce the yield to a very marked extent.

Symptoms—These are very variable. Affected plants are always more or less dwarfed and in some varieties the leaves assume a characteristic upright, almost staring habit instead of drooping over in the normal way. This symptom is sometimes absent, and instead the plants present a low-headed bushy appearance. When the crop is badly affected the poor growth of the foliage is very noticeable. It is practically never as green on affected plants as on healthy ones, and occasionally on certain varieties it takes on a purplish or reddish colour at the tips and around the margins of the leaves. Rolling of the lower leaves is always associated with the disease. The rolling is often rather inconspicuous and may not extend beyond the leaves lying close to the ground although it may affect the intermediate and even the topmost leaves. Marked rolling of the upper leaves, however, is often seen on plants not affected with Leaf Roll. The rolled leaves of plants affected with this disease begin to die early. The harsh leathery texture of such leaves is a constant symptom. This point may be tested by feeling them with the fingers. The tubers of affected plants are small and are borne generally on very short tuber branches (stolons) or even attached in a cluster to the stem.

Cause—This is one of the virus diseases. Aphids or plant lice have been shown to be the chief carriers of the virus although it is probable that they are not the only carriers. The disease does not live over winter in the soil unless tubers that might produce volunteer plants are left in the field at digging time. Leaf Roll is transmitted chiefly through the "seed". Tubers from affected plants nearly always produce diseased plants.

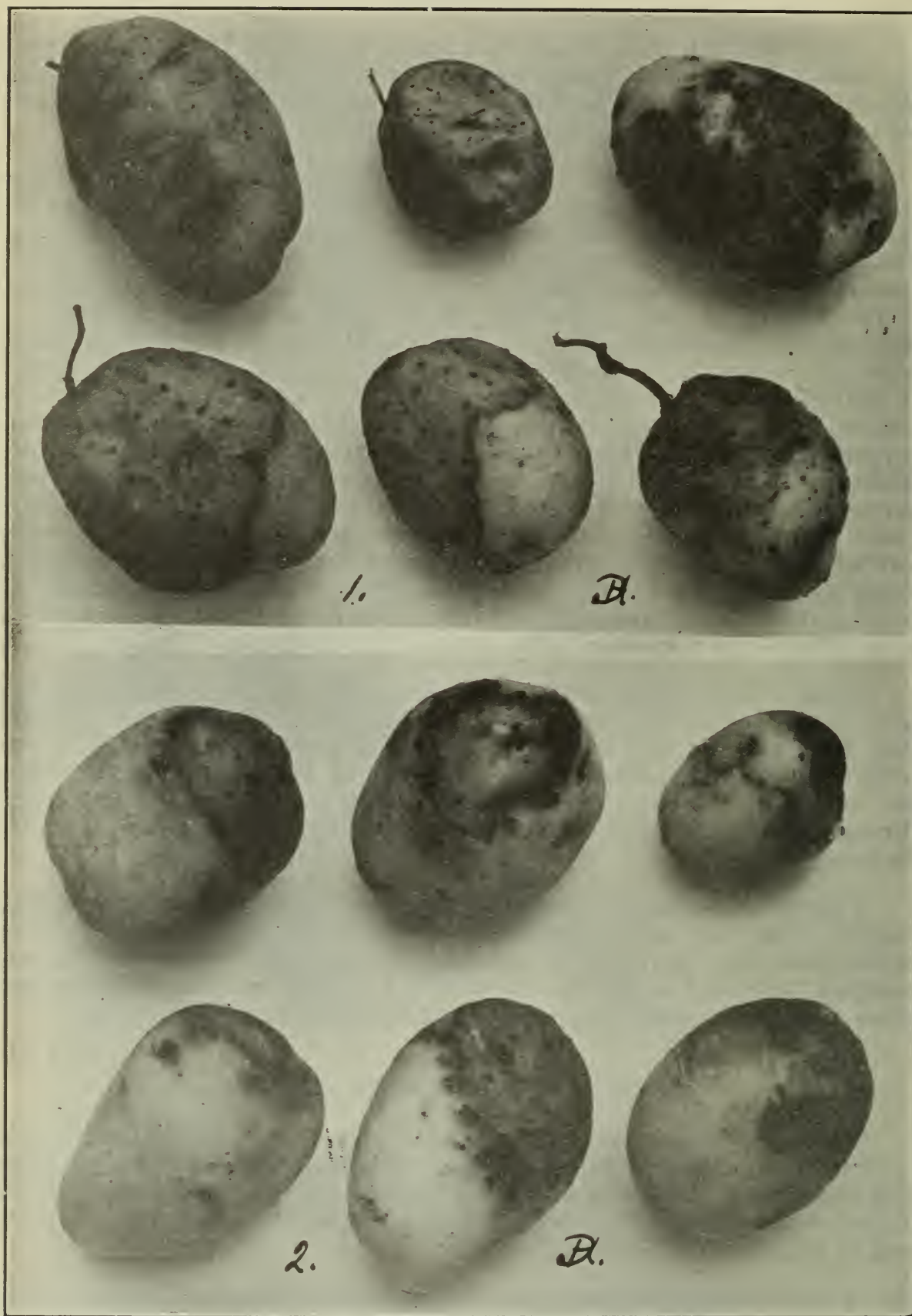
Control—The most important means of control is the use of healthy "seed". The man who is growing potatoes for table stock can avoid serious loss from Leaf Roll by purchasing from time to time certified seed potatoes. Certified seed potatoes should be planted at some distance from other potatoes in order to prevent Leaf Roll being carried to them.

OTHER IMPORTANT VIRUS DISEASES

There are several other important "virus" or degeneration diseases in Ontario, chief among which are the potato Mosaics, which cause mottling and crinkling of the leaves and sometimes dwarfing of the plants. Spindly Tuber, which causes the tubers to become markedly elongated, off colour and in severe cases abnormally rough.

Plants affected by these virus diseases never recover. They are transmitted through the "seed". Tubers from affected plants produce diseased plants. In the field insects spread the infection. Plant lice (aphids) are chiefly responsible for spreading the various types of Mosaic.

Control—Use healthy "seed". Purchase from time to time certified seed potatoes and plant them at some distance from other potatoes to prevent these virus diseases being carried to them.



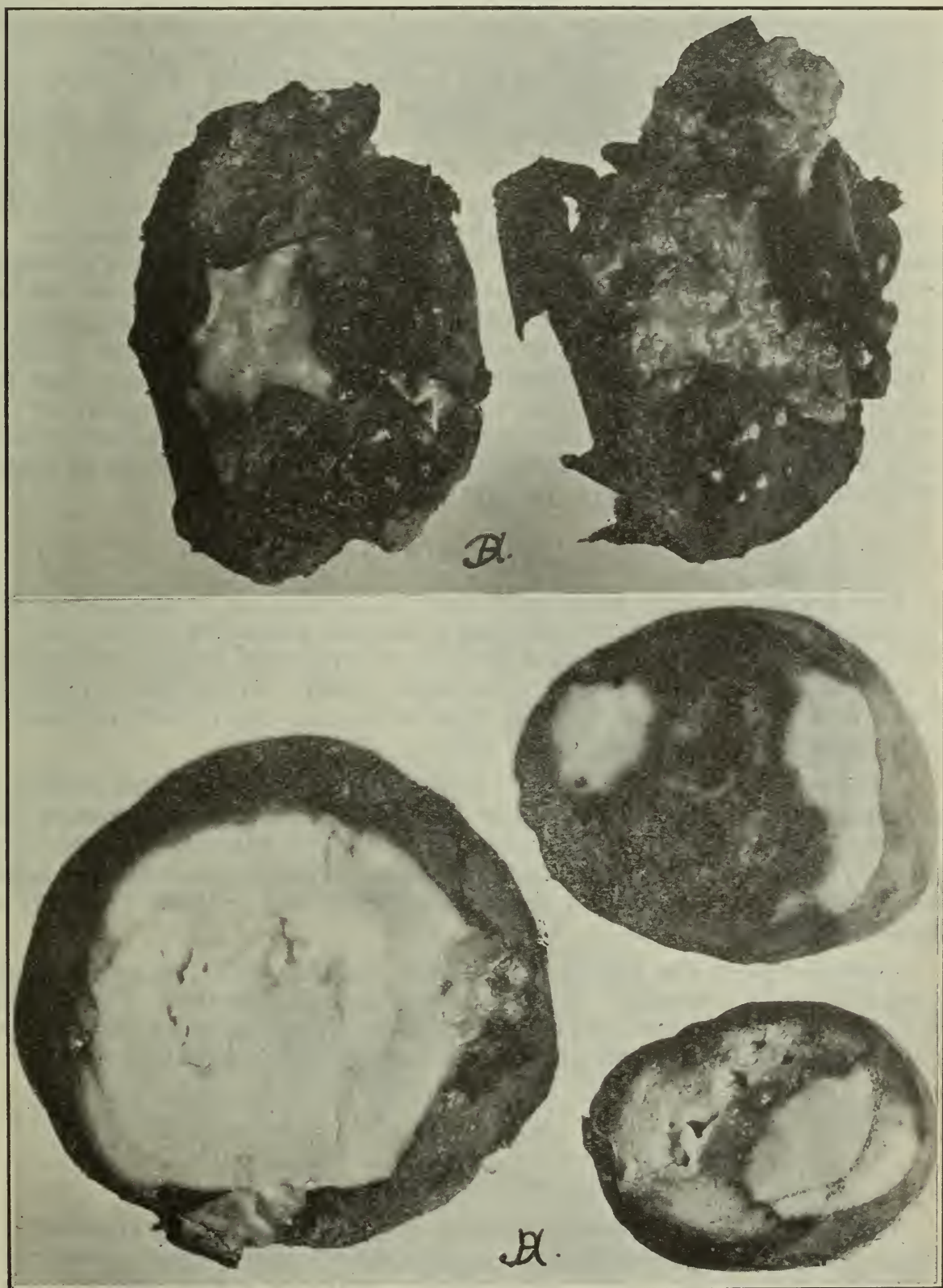
Potato Tubers, showing Bacterial Soft Rot in various stages of development, some tubers entirely rotted, others only partially affected.

1. Six tubers that contracted the disease directly through the stem from the parent plant.
2. Six tubers that contracted the disease at the eye and from coming in contact with other diseased tubers.

BLACKLEG, BASAL STEM ROT OR BACTERIAL SOFT ROT OF POTATOES

This disease is common and destructive in Ontario, and in wet seasons may cause very extensive losses in the potato crop.

Symptoms—The first symptom of the disease in those parts of the plant above the ground is a wilting or yellowing of the lower leaves. Later the upper leaves become yellow, reddish-yellow or even brown with an



Tubers in advanced stages of the Bacterial Soft Rot, taken directly from the field.

upward and inward rolling. There is also a tendency for the stems to grow erect instead of spreading out. The base of the stem from the seed piece to the surface of the ground, or even three or four inches above the ground in severe cases, will be found to be black. It is from this symptom that the disease derives its name Blackleg. The tubers are infected at the stem end first and may be partly or completely rotted. The disease is most destructive during warm, moist weather.

Cause—This disease is caused by the bacterial organism *Erwinia phytophthora* Appel. In most of the literature dealing with this disease the causal organism is given as *E. atroseptica* or *E. phytophthora*. The bacteria are carried over in the soil and on diseased tubers. The seed pieces are often infected by the seed corn maggot before planting. The maggot, contaminated with the organism from infested soil, or infected plant parts, carries to the seed pieces.

Control—Only certified seed potatoes from disease-free plants should be used. When a stock of seed potatoes has shown a small percentage of disease all those tubers having dark spots in the flesh should be discarded, and the remainder should be treated by immersing them, previous to cutting, for one and one-half hours in corrosive sublimate, one part to 1000 parts of water (one tablet to a pint of water), or in formalin one pint to thirty gallons of water. Decay during storage of potatoes may be checked by storing them dry, in well ventilated cellars, at about 38° F. Long rotation of crops is recommended, but as the causal organism infects nearly all vegetables this means using the field for such crops as sweet corn or other cereals, clovers and grasses.

TIP-BURN OR HOPPER-BURN OF POTATOES

This trouble is very frequently seen in abundance in Ontario in hot dry summers. When serious it causes a marked reduction in the yield.

Symptoms—There is at first a slight wilting and rolling inwards of the edges of the leaves which soon turn brown. When the trouble is serious this browning and curling may extend to the midrib or near it over a considerable portion of the leaves.

Cause—There are two types of injury, (1) true tip-burn which is the result of hot sunshine and warm dry winds causing an excessive loss of water from the leaf tissue; (2) hopper-burn caused by apple leaf hoppers (*Empoasca mali*) puncturing the leaf veins and sucking the juice. This insect may often be seen rising in swarms as one walks through an infested field.

Control—Keep the soil rich in humus and see that the potatoes are repeatedly and thoroughly cultivated to conserve moisture. Spray with Bordeaux mixture as for Late Blight and Rot. Spraying has a direct effect on the true tip-burn as well as acting as a repellent for leaf hoppers.

TOMATOES

LATE BLIGHT OR LEAF SPOT OF TOMATO

This is the most common disease of field tomatoes in Ontario. In certain sections of the Province it causes serious loss to tomato growers by destroying the foliage early in the season, with the result that the fruit does not ripen properly or is sunscalded. It causes most damage in seasons of high temperature and high humidity.

Symptoms—Late Blight or Leaf Spot is easily recognized by the small, grayish-brown angular spots containing minute black specks which appear on the leaves and stems. Badly spotted leaves wither and dry up. The lower leaves are first affected and the disease spreads upwards, often completely destroying all the foliage of the plants except the new growth near the tips. Sometimes small spots occur on the fruit also.

Cause—The fungus which causes this disease is *Septoria lycopersici* Speg. This fungus produces countless spores in little black fruiting bodies (pycnidia) in the diseased spots on the leaves. During periods of high temperature and excessive humidity these spores are liberated and carried to other leaves or nearby plants by insects, wind, rain and the hands and clothing of pickers. This fungus is carried over the winter in the diseased leaves and stems, and in the remains of certain weeds which are also attacked by it.

Control—This disease frequently starts in the seed bed. In order to prevent this the following precautions should be taken. Any wood around the seed bed should be drenched with a solution of formalin (one pint to twenty gallons of water). If Leaf Spot has been prevalent in former years the soil in the seed bed should be renewed or sterilized with steam or formalin. (See directions on pages 64 to 68.)



Leaf Spot of Tomato. (Attacked leaves and stem).
(From Ohio Bulletin 73).

Experiments have been conducted for several years in spraying tomatoes in the seed bed only and spraying them both in the seed bed and in the field. The results of these experiments warrant spraying tomatoes only in the seed bed.

Directions for Spraying Tomatoes—Spray the plants in the seed bed when the first true leaves have appeared and again three or four days before they are taken to the field. Use a 2-4-40 Bordeaux mixture, adding three pounds Resin Fish Oil Soap to each 40 gallons. Water the plants well before spraying or as soon as the spray has dried on the leaves after spraying. Apply the spray at a pressure of 170 to 200 pounds. Do not hold the nozzle too close to the plants and do not overspray.

Some men prefer dusting although it does not give as much protection from diseases as spraying. Dust three times with a 20 per cent. copper lime dust, making the first application when the first true leaves have appeared and the other two at intervals of ten days. Do not allow large quantities of dust to fall on the plants as burning may result.

If Leaf Spot is very troublesome a rotation of crops should be followed so that tomatoes are not grown upon the same piece of ground oftener than once in three or four years. When such a rotation of crops is followed it is much easier to keep Leaf Spot under control.

EARLY BLIGHT, BLACK ROT, TARGET SPOT

This is a very common disease of tomatoes in Ontario. In wet seasons it causes very serious losses to the growers of canning tomatoes in Eastern Ontario.

Symptoms—On the fruits are seen dark brown or black sunken rotten spots. Some of these may be an inch in diameter. The discolourations from the rot usually extend to the centre of the fruit rendering it unfit for canning purposes. On the leaves may be observed somewhat circular, dark brown spots which are sometimes one-half an inch in diameter. They are readily recognized by the peculiar ring-like or target-like markings, hence the name "Target Spot". The spotting of the leaves is of comparatively little importance. It is the rot on the fruit that causes the loss.

Cause—The fungus *Macrosporium solani* E. & M. which causes Early Blight of potatoes is also responsible for this disease. The life history of this fungus is described under the cause of Early Blight of potatoes. (See page 38.)



Blossom End or Point Rot of Tomatoes. (Original).

Control—The directions given for the control of Leaf Spot of tomato apply also to the control of this disease.

BLOSSOM END ROT OF TOMATOES

This trouble is very common in Ontario both in tomatoes grown outdoors and under glass. It is most abundant outside in seasons when periods of hot dry weather alternate with those of heavy rainfalls.

Symptoms—The trouble appears usually when the first fruits are about half grown or a little later. Slightly sunken water-soaked areas are seen near the tip of the fruit. These are at first lead coloured or brownish but soon become lead-brown or black in colour and of a leathery texture. Various fungi and bacteria may gain entrance through these injured spots and cause rot which may destroy the whole fruit.

Cause—This disease is caused by unfavourable environmental conditions. Irregularities in the water supply and excessive nitrogen in the soil appear to be the two chief factors bringing about the development of this trouble.

Control—Avoid excessive applications of manure or other fertilizers which are high in nitrogen. Do not over force the plants, especially in the early stages of their development. Endeavour to maintain a state of even growth throughout the life of the plant. The water supply of tomatoes, grown under glass, should be even and regular. Outdoor tomatoes should be grown on well drained soil containing plenty of humus to retain moisture during dry weather. It is almost impossible to prevent this trouble on light, sandy soils lacking humus. In a dry period cultivation should be very shallow, just deep enough to fill any cracks that may appear, and to kill weeds. In wet weather the soil should be stirred enough to cause the excessive water to evaporate.

TOMATO MOSAIC

This disease is frequently seen in Ontario both in the field and under glass. It is not an uncommon thing to see fifty per cent. or more of the plants in a greenhouse affected by Mosaic.

Symptoms—There are two kinds of Mosaic of tomatoes, namely, Common Tomato Mosaic and Shoe String Mosaic. Plants affected with Common Tomato Mosaic have the leaves crinkled and mottled with yellow and green. Sometimes the yellow areas die and turn brown. Badly affected plants are dwarfed and usually set but a few fruits. Sometimes the fruit of diseased plants is russeted, streaked or blotched with raised areas.

The segments of the leaves on plants affected with Shoe String Mosaic are so narrow and slender as to appear almost thread-like.

Cause—Common Tomato Mosaic is caused by the same virus which affects tobacco and other closely related plants. This virus is spread by plant lice (aphids) and other sucking insects and by workmen, pruning and tying plants in the greenhouse or field. It will live in the soil for at least two months. It winters over in old tomato plants in the greenhouse and in the roots of perennial weeds which are closely related to the tomato, such as ground cherry (*Physalis spp.*). There is considerable evidence to show that sometimes this virus may be carried over from season to season in the seed. It has been shown that it may live for a long time in tobacco, especially chewing tobacco, cigars and cigarettes. Workmen may, therefore, spread the disease by handling tomato plants when smoking or after

smoking if the hands are not thoroughly washed before handling tomatoes. They may also spread it to the seedlings in the seed bed by expectorating over them when chewing tobacco.

The Shoe String Mosaic is caused by the virus which affects the cucumber and closely related plants. It lives over the winter in the roots of the perennial weeds mentioned on page 24.

Control—All weeds belonging to the potato family, such as ground cherry, horse nettle, black nightshade, bittersweet and other related plants growing in the neighbourhood of the greenhouse, the seed bed and the tomato fields should be destroyed. All tomato refuse in the greenhouse and in and around the seed bed should be burned. The young tomato plants should not be placed in a greenhouse containing old plants. Since the virus can live in the soil the new crop of tomatoes should not be started in the seed bed or set in the greenhouse for at least four months after the crop has been removed. So far as possible control plant lice (aphids) by dusting, spraying or fumigation. In working among tomatoes the hands should be washed occasionally with soap and water and the pruning knife dipped repeatedly in formalin (one part in twenty parts of water). Breaking off the undesirable shoots in pruning permits less chance of infection than does cutting. Do not plant any of the following crops near tomatoes; potatoes, petunias, eggplants, peppers, cucumbers and other susceptible crops as the Mosaic may spread from them to tomatoes. Tobacco should never be used when working with tomatoes, especially cigars, cigarettes and chewing tobacco, and workmen who smoke should wash their hands thoroughly after smoking before handling tomato plants.

STREAK OR WINTER BLIGHT OF TOMATOES

This is one of the most troublesome diseases of greenhouse tomatoes in Ontario. It often causes the loss of nearly the whole crop. It sometimes appears in the field but seldom causes severe loss.

Symptoms—The first indications of Streak are a rank sappy growth and the curling of the upper leaves and the younger portions of the stems and brown, sunken streaks or stripes on the young, vigorously growing stems. These streaks increase in width until the whole upper part of the stem may become brown. At first the browning appears to be on the surface only, but it soon becomes deeper seated and in bad cases involves the woody ring. About the time the first indication of streaks appear on the stem, brown angular spots appear on the leaves between the veins and these spots increase in size and number until the whole leaf is involved. Fruit sets very sparingly, often none on the first two or three trusses. The fruits that do set are commonly scabby, deformed and of poor flavour and colour. Large, soft, sappy plants are most subject to this disease. It is frequently accompanied by Mosaic.

Cause—Recent investigations in Canada and the United States have shown that Streak can be produced by a complex of viruses within the tissues of the tomato plant. A double inoculation with tomato mosaic virus and latent potato virus (mottle) or tomato mosaic virus and cucumber mosaic virus results in Streak, which can be transmitted in this form. Most investigators agree that Streak develops more rapidly and causes more serious losses in tomatoes which have been forced into too vigorous sappy growth by the use of fertilizers containing an excess of nitrogen. Any cultural practice which rapidly forces the plants into excessive growth appears to make them much more susceptible to Streak.

Control—Dr. R. E. Stone, of the Botanical Department, Ontario Agricultural College, has been carrying on investigations concerning the control of Streak for several years. As a result of these investigations he makes the following recommendations: Take all the precautions recommended for the control of Mosaic. Avoid the use of too much manure or other nitrogenous fertilizers such as ammonium sulphate or sodium nitrate. Be sure that the plants have plenty of phosphorus and potash. These elements may be supplied by using an 0-12-10 fertilizer at the rate of three to three and one-half pounds per 100 square feet of bed. This material should be worked into the soil before transplanting. If Streak appears apply acid phosphate, three ounces, and potassium sulphate, one-quarter ounce, as a side dressing to diseased plants. Avoid over-watering and irregular watering. Do not attempt to force plants that have been checked. Keep the plants growing evenly by maintaining a uniform temperature and watering regularly but not too heavily. Maintain a firm growth by providing good ventilation.

LEAF MOULD

This disease frequently causes serious loss in greenhouse crops of tomatoes. It also occurs to a lesser degree in the field.

Symptoms—The leaves, especially the lower surface, become covered by an olive-brown mouldy or felt-like fungus growth. Affected leaves turn yellow or brown and in severe cases shrivel and die.

Cause—This disease is caused by the fungus *Cladosporium fulvum* Cke. This fungus is carried over from season to season in old diseased leaves in the soil of the greenhouse. It thrives best in a humid atmosphere and is very susceptible to temperature. The spores germinate best at a temperature of from 65° to 75° F. They will not germinate in a relatively dry atmosphere. Cloudy days increase the virulency of this organism.

Control—This Leaf Mould can develop only in almost completely saturated air. The management of the greenhouse, therefore, should be such as to keep the humidity too low for the growth of the fungus. Proper ventilation of the greenhouse is of prime importance. This can be accomplished by opening the ventilators and providing a little more heat if necessary. Some growers have found it profitable to instal electric fans of various types to keep the air in circulation. Space the plants far enough apart so that air can circulate freely amongst them and expose them to all the sunshine available. Wet the foliage of the plants as little as possible when watering, which is best done in the mornings of sunny days. If the Mould develops in cold weather lower the night temperature of the house to 55° F. for several nights in succession. In greenhouses, which are poorly lighted and poorly ventilated, spraying with Bordeaux mixture 4-8-40 may be of some value. Apply the Bordeaux heavily with high pressure at weekly intervals. Some growers recommend fumigating the house with sulphur. This is done by heating sulphur in porcelain dishes on electric heaters placed at regular intervals throughout the house. This fumigation with sulphur is done for a two-hour period just before the house is closed for the night and repeated at weekly intervals as long as there is danger from Mould. If fumigation with sulphur is attempted care must be taken not to get the sulphur hot enough to burn for it will then injure the tomato plants. Varieties of tomatoes resistant to Mould are being bred and it is hoped that they may soon be available to growers.

LEATHER END OR YELLOW END OF TOMATOES

This disease occurs in all the tomato growing areas of Ontario but is particularly troublesome in the Eastern Ontario district which includes parts of Durham, Northumberland, Hastings and Lennox and Addington counties and all of Prince Edward. It attacks both field-grown and greenhouse tomatoes although in the case of the latter it usually appears only in the spring crop. All of our commonly grown varieties are susceptible but some, especially those of the Earliana type, are much more so than others. This disease may cause some loss to growers of greenhouse and early market tomatoes, but it is most serious in canning tomatoes. In seasons favourable to the development of the disease, as much as fifty per cent. of the canning crop may be affected while in other years only five or six per cent. is diseased. The loss to the grower comes as a result of having the grade of his tomatoes considerably lowered or having a certain per cent. docked on account of the presence of diseased fruits. The canner also suffers loss since the diseased portions, which cannot be processed, have to be cut away and a great deal of wastage results. When the diseased portion is cut away the seed locules are usually opened so that there is considerable loss in addition to the part actually removed.

Symptoms—This disease may be recognized by the failure of the stem end of the fruit to ripen properly. Instead of becoming red ripe like the rest of the fruit, the area around the stem remains a greenish yellow, yellow or bronze in colour and is quite hard and leathery in texture. Sometimes almost a third of the fruit is involved and the diseased portion never ripens no matter how long the fruit is left on the vine. Only the wall of the fruit is involved and the inside of the tomato in the diseased portion may be quite normal.

Cause—Leather End is a disease caused by faulty environment. The exact causal factor has not been determined, but experiments have indicated that exposure to sunlight combined with high temperatures are favourable to the development of the disease. Defoliation increases the amount of disease, and shading, even when the foliage is removed, gives almost one hundred per cent. control. Any other factor such as moisture supply, soil fertility, etc., which influences the amount of vine growth will in turn have an effect on the amount of disease. Poor vine growth is always associated with severe attacks of Leather End. This probably accounts for the disease being worse on sandy soils since the vine growth in such soils is usually less than where the soil is heavier.

Control—Leather End may be greatly reduced by having the land on which the tomatoes are grown in a good state of fertility with an ample supply of organic matter, and by giving in addition an application of a complete fertilizer, carrying at least six per cent. of potash and on lighter soils ten per cent. of potash. If the humus content of the soil is low the fertilizer should contain at least four per cent. of nitrogen but this element is best supplied by decaying organic material. The following suggestions are made regarding the use of commercial fertilizers in the control of this trouble: On loam to clay-loam soils use a 2-12-6 analysis at the rate of 500 to 700 pounds per acre, and on sandy loam to sandy soils use a 2-12-10 analysis at the same rate. In either cases, if there has been no legume crop, such as clover, sweet clover or alfalfa preceding the tomatoes, a side dressing of nitrate of soda or ammonium sulphate at the rate of 200 pounds per acre should be given in addition to the complete fertilizer. This side dressing may be given about two weeks after the plants are set out into

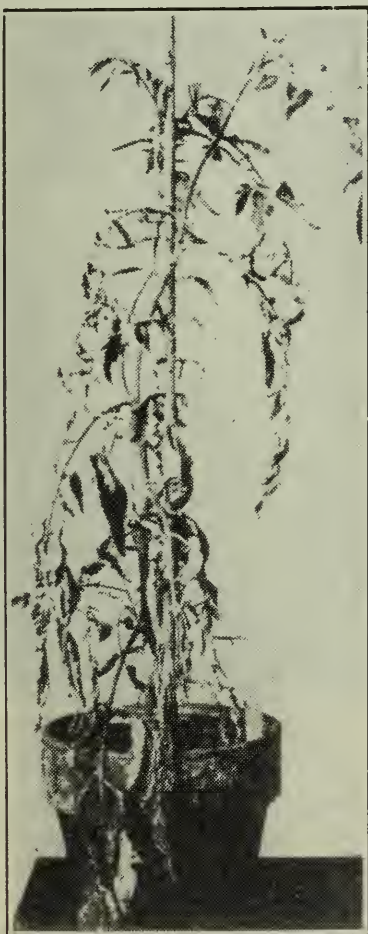
the field. Ultimate success in the control of this disease depends upon ample vine growth for the protection of the fruit. In addition to the above recommendations, open growing varieties such as Earliana should be avoided in areas where Leather End is prevalent.

BACTERIAL CANKER OF TOMATOES

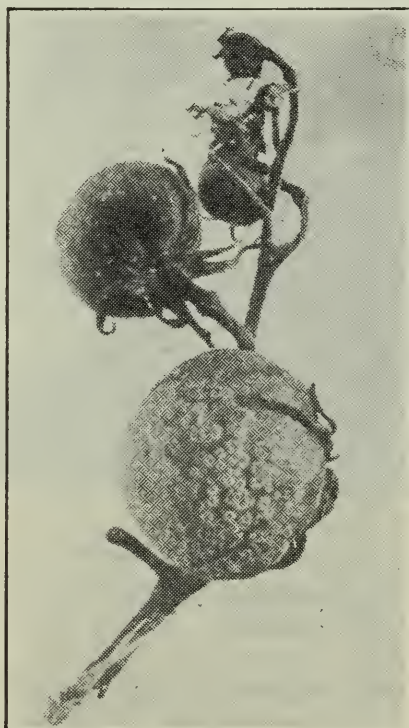
This disease is sometimes found in Ontario but so far has not caused any serious loss, though a number of enquiries have been received concerning it.

Symptoms—The chief symptoms of this disease are seldom observed until the plants begin to blossom. About this time there is a wilting, rolling, and browning of the leaves on one side of the plant. These symptoms are followed by the appearance on the stems of yellowish-white streaks, which later become grey-brown, and crack open, forming cankers. From these cankers bacteria emerge to the outer surface. In extreme cases the pith of the stem collapses and becomes discoloured. The disease extends rapidly up the stem, and if the fruit is set it becomes stunted and distorted. There is a yellow to brown discolouration of the inside of the fruit, and also irregular somewhat sunken spots on the exterior. This disease differs from the Fusarium Wilt in that it does not cause sudden wilting of the entire plant.

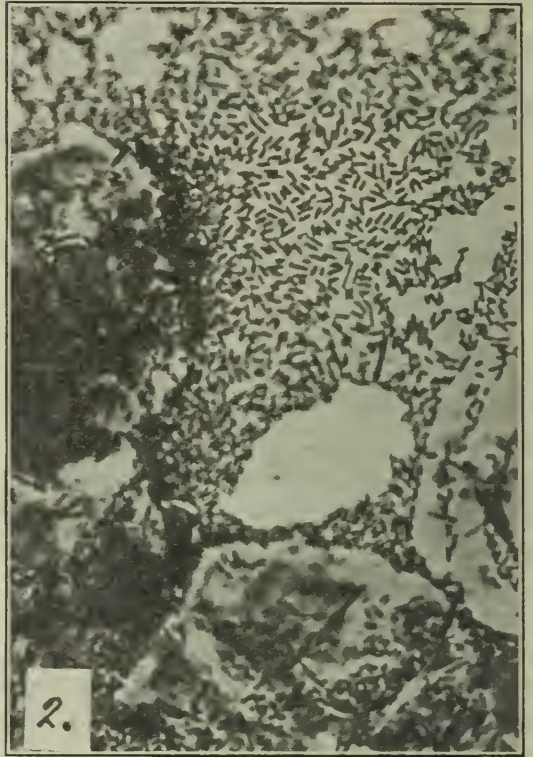
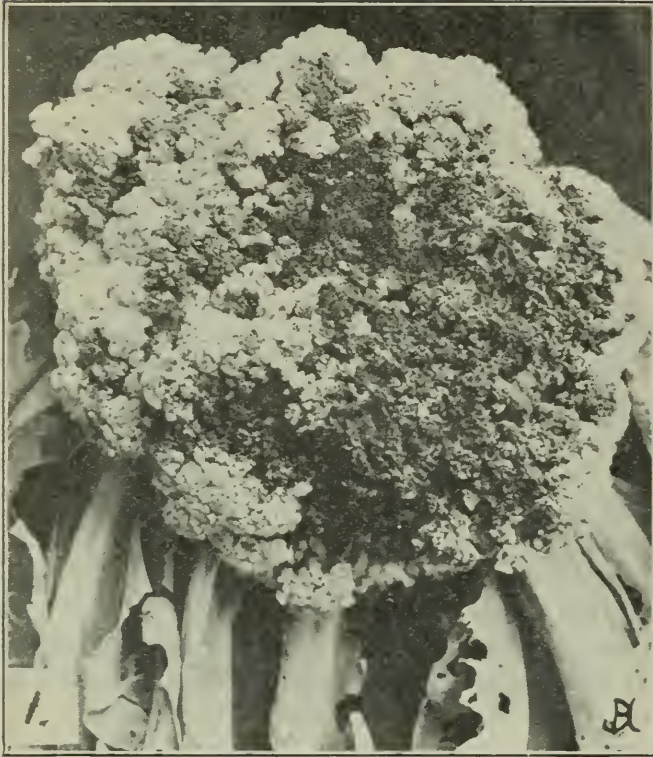
Cause—This disease is caused by the bacterial organism *Phytomonas michiganense* (E. F. Smith), Bergey et al. The bacteria winter over on the seed and in old diseased plant refuse. They may enter the plant through the breathing pores (stomata), but usually infection is through the food and water conducting vessels of the plant.



Tomato vine affected with Bacterial Canker.



Bacterial Canker spots on tomato fruit.
(After Chupp).



Bacterial Soft Rot of Cauliflower and Cabbage.

1. Bacterial soft rot of cauliflower, natural infection; specimen taken direct from garden.
2. *Erw. caratovora*, the vegetable soft rot bacillus seen between cells of broken-down, rotting cauliflower. (x 1000 di.)
3. Bacterial soft rot of cabbage. Artificial stab inoculation of a pure culture of *Erw. caratovora* in healthy cabbage. Photo taken twenty days after inoculation.

Control—Care should be taken to select seed from healthy plants. Seed may be treated by tying it loosely in a cheesecloth bag and submerging it in corrosive sublimate, one part to 3000 parts of water (one tablet to three pints of water) for five minutes, after which it should be washed in clear water. If this disease becomes troublesome crop rotation should be followed so that tomatoes are not grown on the same land more than once in three or four years. Tomato refuse should be ploughed in deeply or destroyed.

BACTERIAL SOFT ROT OF VEGETABLES

This disease affects many fleshy vegetables and flowers, especially turnips, cauliflowers, potatoes, carrots, cabbages, celery, tomatoes, German iris and calla lily, and to a lesser extent, onions, asparagus, salsify, sugar beet, mangel, muskmelons and others.

Symptoms—It would require a very lengthy discussion to deal with minor symptoms as they occur in the various plants, and this is considered unnecessary since the general symptoms serve to identify the disease.

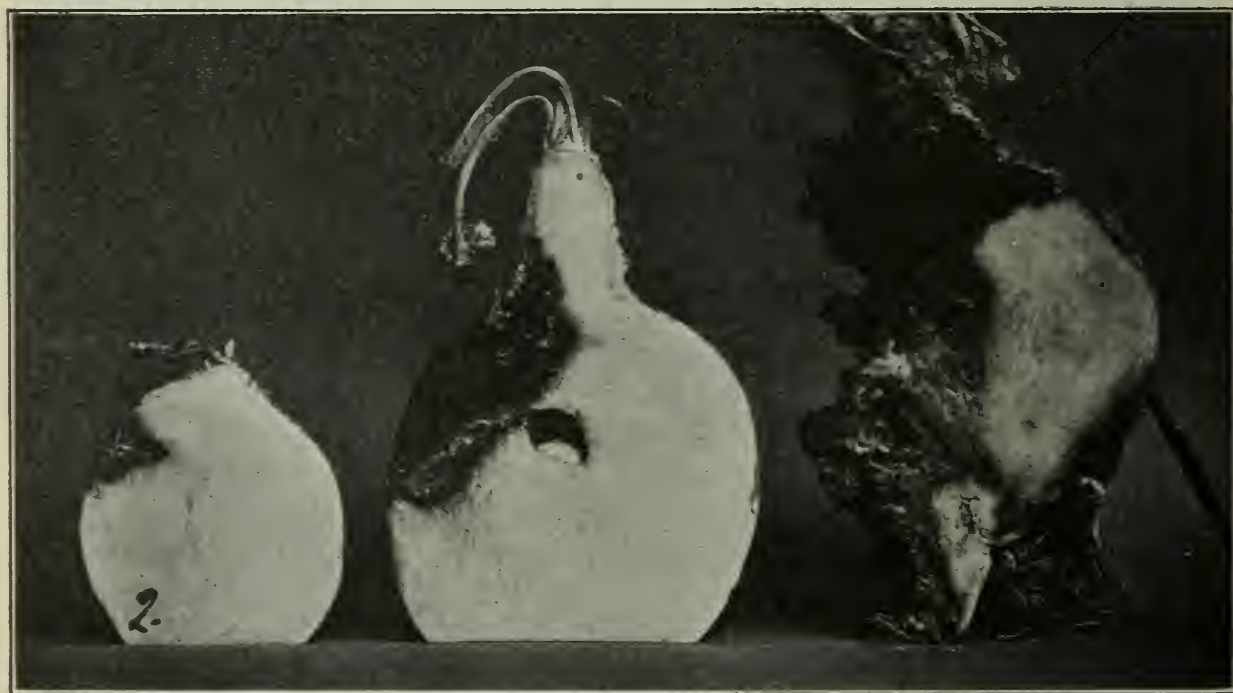
The organism causes a progressive soft, wet rot of affected roots, rhizomes, fruits, fleshy stems and leaves of vegetables and other plants. The rotted portion varies in colour from reddish-brown to dark brown or black in the case of affected green tissues. There is a clear line of demarkation between the healthy tissue and the diseased tissue. This is explained by the fact that, as the organism multiplies it produces digestive enzymes, which act upon the healthy tissue making it soluble and available as food for the bacteria. The middle lamella or the cementing material which holds the cells together to form vegetable tissue, is first attacked so that the cells collapse. This results in a soft rotten mass, dark in colour, with an offensive odour. When the disease occurs in the cauliflower it most commonly affects the head, but may also affect the leaves and stem. The usual discolouration and rot of the head soon becomes noticeable. In the turnip, the rot usually starts at a wound near the crown, and progresses through the root.

Cause—This disease is now known to be caused by the bacterial organism *Erwinia caratovora* (Jones) Holland. It is incapable of penetrating sound tissue, and is introduced into the plant on the mouth parts of insects which have previously fed on diseased plants, or it may gain entrance through wounds caused during cultivation and handling of the plants.

Control—Spraying with insecticides is beneficial indirectly since it helps to keep down insects, but spraying with fungicides is of little or no avail. When storing vegetables, only those free from any indication of disease should be kept. Before storing, the vegetable house should be washed or sprayed with formaldehyde, one pint in ten gallons of water, or copper sulphate one pound in five gallons of water. Good ventilation should be supplied and a temperature a little above 32° F. maintained, but freezing should be avoided since tissues weakened by freezing may be attacked by other bacteria. Long rotations with immune crops such as corn, cereals and grasses are recommended. Applications of lime and superphosphate are said to reduce the severity of this disease.

DAMPING OFF

The seedlings of many plants are liable to be affected by this trouble. It occurs mostly in the seed bed where plants are growing in a crowded



Bacterial Soft Rot of Turnip.

1. Turnips direct from field badly affected with bacterial soft rot. Shaded areas were soft, pulpy and strong smelling. Evidently inoculated near the crown, probably through wounds made by slugs or caterpillars or during cultivation.
2. Soft-rotting turnips direct from field, in which the disease had been prevalent the previous year. These had evidently been inoculated from the soil through wounds made while hoeing or cultivating.

condition. It is seldom found in the open field. It is also a common disease in greenhouses where relatively high humidity is maintained and where the plants are not exposed to sunshine and free circulation of air.

Symptoms—The stems near the ground are girdled by brown lesions which cause the plants to fall over and ultimately die.

Cause—Rhizoctonia, species of Fusarium and Pythium are the fungi causing most of this trouble.

Control—If serious Damping Off has occurred at some time, the soil should not be used again or, if used, it should be sterilized with steam or formalin (see page 64). In order to prevent the accumulation of too much moisture in the surface soil and to reduce the humidity of the air about the plants: (1) sow the seed in rows and not too thickly; (2) sprinkle a layer of coarse, dry sand over the surface of the soil; (3) stir the upper layers of the soil frequently; (4) in cool, damp, cloudy weather ventilate freely and supply plenty of heat if possible; (5) water the plants in the morning rather than in the late afternoon or evening; (6) avoid over-watering.

Proper seed treatment often does much to increase stands and control Damping Off. Treated seed may be stored for short periods of time without injury but it is preferable to apply the treatment just as the seed is required. There are various mercuric compounds on the market that many growers are using successfully for treating seed. These compounds should always be applied according to the directions on the container. Red Copper Oxide has been found satisfactory for the prevention of Damping Off in many crops. The method of application is to place the seed and the dust in a closed container and shake the container vigorously for two or three minutes so that every seed will be coated with the dust. In order to allow the seed and the dust to mix properly the container should not be more than half filled. A pint or quart glass sealer is very satisfactory for treating small quantities of seed. Packet seeds may be treated in the packets. The following rates of application are suggested: One level teaspoonful per pound of seed for seeds the size of spinach or smaller and for light seed like beets or chard, and one teaspoonful per ten pounds for larger and heavier seeds like peas, squash and cucumber. Any excess of dust should be screened out before the seed is sown.

Caution—Red Copper Oxide should not be used on the seeds of plants belonging to the mustard family, such as cabbage and cauliflower.

Treating the seed will prevent it from rotting and afford protection to the young plants from fungus attack before they emerge from the soil. It will not, however, effectively prevent Damping Off after the seedlings are up for two or three days. If Damping Off develops in the seed beds at this time there are two treatments that will check it. The first treatment consists of the use of Zinc Oxide which is sold commercially under the name of Zinc White and is used for making zinc paints. It is used at the rate of about one-half ounce per square foot of soil and is sprinkled on the dry plants in the afternoon or on a cloudy day and then brushed off onto the soil. Sufficient material should be applied to give a smooth white layer over the soil. This layer should be left in contact with the plants until the danger of Damping Off is past. Water carefully so as to disturb the layer as little as possible. The second treatment is the use of Red Copper Oxide in the form of a spray. The Red Copper Oxide is used at the rate of one pound in forty gallons of water and is sprayed on the young plants so that



Bacterial Soft Rot of Celery.

1. Artificial needle inoculation of pure culture of *Erw. caratovora* (isolated from rotting cauliflower) into the young and vigorous growth of celery. Five days after inoculation, kept at 25° C.
2. Same as Fig. 1, five days later.
3. Same as Fig. 1, ten days later.
4. Same as Fig. 1, three weeks after inoculation, showing complete collapse of plant.
5. *E. carotovorous*, the vegetable soft rot bacillus, between the cells of rotting celery tissue (x 1000 di.).

it will run down the stems to the soil level and also wet the surface of the soil. If Damping Off is feared the surface of the soil may be sprayed before the seedlings emerge. This treatment is less expensive and easier to apply than the Zinc Oxide.

FUNGICIDES

BORDEAUX MIXTURE

This is almost the only spray used on vegetables for the prevention of fungus diseases. The two formulae recommended for the preparation of Bordeaux mixture for spraying vegetables are: (1) Bluestone (copper sulphate) four pounds, hydrated lime five pounds or fresh stone lime four pounds and water forty gallons; (2) Bluestone three pounds, hydrated lime four pounds or fresh stone lime three pounds and water forty gallons. Hydrated lime is the more convenient form to use as it does not require slaking. It can be purchased in fifty-pound paper sacks and is easily stored. If left exposed to the air, however, it becomes worthless, so keep it in tightly fastened paper bags in a dry place.

To prepare Bordeaux Mixture:—Dissolve the bluestone, then nearly fill the tank with water. Add the proper amount of dissolved bluestone. Then while the engine is running add the hydrated lime or slaked stone lime and agitate the mixture for about five minutes. If a hand outfit is used put end of the hose in the tank and agitate by pumping the liquid back upon itself for five minutes.

N.B.—The easiest way to dissolve bluestone in the crystal or lump form is to place forty pounds of it in a bag and suspend this in a barrel containing forty gallons of water, in such a way that the bottom of the bag sinks only three or four inches below the surface of the water. Leave over night and in the morning all will be dissolved. One gallon of the liquid will now contain one pound of bluestone. Small quantities can be dissolved readily by stirring in boiling water. Granulated bluestone dissolves very readily. If the desired amount is placed on a burlap screen over the opening in the tank it will dissolve while the water passes through it to fill the tank.

COPPER LIME DUST

(Bordeaux Dust)

Some growers prefer to use this dust instead of the liquid Bordeaux. It is made of very finely ground bluestone (copper sulphate) and the best grade of chemical hydrated lime. Calcium arsenate is sometimes added for a poison. The formulae most generally used are: (1) twenty pounds bluestone and eighty pounds lime; (2) twenty pounds bluestone, sixty pounds lime and twenty pounds calcium arsenate. The best results from dust have been obtained by applying it liberally with a high-powered duster when the plants were wet with rain or dew.

RESIN FISH OIL SOAP

Resin Fish Oil Soap is used with Bordeaux when a sticker is required to make the fungicide adhere better to the foliage. Three pounds of the soap are used with each forty gallons of the Bordeaux. The soap is first mixed with water, using one gallon of water for each pound of soap. Hot water is preferable to cold water.

FORMALIN

Formalin is a clear liquid disinfectant. It is a 40 per cent. solution of formaldehyde gas in water. It is sold under the name of formalin and fermaldehyde. It can be purchased in a drug store by the pound (sixteen ounces) or by the pint (twenty ounces). It is important that the purchaser secures a solution of full strength at least not less than thirty-eight per cent. The solution should be kept in a well-corked container and away from the frost. Formalin when diluted with water is not a dangerous poison, although a weak solution will make the eyes smart and a strong solution will harden the skin temporarily.

CORROSIVE SUBLIMATE (MERCURIC CHLORIDE)

Corrosive sublimate may be obtained from any druggist. This is a deadly poison and should be so labeled and kept out of the way of children and stock. It is sold as a powder or in the form of tablets, one of which dissolved in a pint of water gives a solution of the strength of one part by weight of corrosive sublimate to 1,000 of water. It is not readily soluble and hot water should be used to dissolve it. It corrodes metal and therefore should be mixed in wooden or earthen vessels. It is an excellent disinfectant but even in dilute solutions it is deadly poisonous. Great care therefore must be used in handling it. Potatoes disinfected with it should never be used as food for man or beast, and vessels which have contained it should be thoroughly washed with hot water before they are used for any other purpose.

SOIL STERILIZATION

Many destructive insect and disease pests live over from crop to crop in the soil, particularly in greenhouses. In order to get rid of these, soil sterilization becomes an important factor in the production of greenhouse crops. Care is required during the sterilizing to see that all parts are thoroughly done and also afterwards, to see that the soil is not reinfected by other soil brought in from another house on contaminated boots or dirty tools. If the soil becomes contaminated just after sterilizing, the disease usually develops more rapidly than it would if no sterilizing had been done.

There are two methods of sterilizing soil, one by using formaldehyde or other soil disinfectants, and the other by using steam. The steaming is preferable as it is more thorough, gives better control of nematodes and plant diseases and kills the weed seeds present. Steaming may also improve the condition of the soil by liberating certain salts that were in the ground but were not in an available form for the plant. In rare cases, however, the crop following steaming is poorer than that previous to steaming as toxic substances which are harmful to growing crops may be liberated during the steaming. All seed beds and greenhouses are not equipped for sterilizing with steam and hence formaldehyde or some other disinfectant must be used.

The term sterilization as used in this bulletin is synonymous with disinfection.

FORMALIN OR FORMALDEHYDE

Use one pint of formaldehyde to ten gallons of water and by means of an ordinary sprinkling can apply this solution at the rate of one gallon to one square foot of soil. If the soil will not absorb one gallon per square

foot make the solution stronger so as to get a pint of formalin on about ten square feet. It may be necessary to use a pint of formalin to six gallons of water and then add the six gallons to ten square feet of soil.

Dig up the soil before treating and as soon as sufficiently dry after treating dig up again. Do not set out any plants or sow any seeds for at least ten days after treating and if not good drying weather leave longer. If the soil is light and likely to dry out quickly it is advisable to cover it for a day or two after treating, using tarpaulin, heavy paper or some such material suitable for this purpose. Formalin, like many other chemical substances, will not control nematodes.

STEAM

Sterilizing the soil with steam is the best method that can be used. As stated above, it not only destroys insects and disease organisms but it also kills weed seeds. The soil should be in a loose condition with no large lumps when steamed. It should not be too wet as it requires much more heat to raise the temperature of wet soil. Soil that is a little too dry for good plant growth is usually in a good state for sterilizing. The water holding capacity of the soil may be changed somewhat during steaming, hence for some time after steaming it may be necessary to use more water at a time and water more frequently. Various methods are used in steaming the soil, some of which are as follows:

1. **INVERTED PAN.** For outside seed beds or for small greenhouses where there are no posts and where nematodes are not giving trouble this method gives good results. If posts are in the way, the soil around them cannot be sterilized in a satisfactory manner and contamination of what has been sterilized soon takes place. When nematodes are present those near the surface may be destroyed but many deeper in the soil will remain.

A pan 6 feet x 12 feet and 8 inches deep made of No. 16 galvanized iron reinforced with angle iron is a convenient size of pan to use. In order to move the pan a handle or large ring should be attached to each corner of it. The pan should be held in place by stones or bags of sand and the soil banked around its edges. The steam should enter in such a manner that it is not forced directly into the soil at the point of entrance. The steam may enter at the central part of the pan and a "T" fitted on the inside so as to force the steam each way, or the steam may enter at one end of the pan, or a bent pipe may be used which will pass underneath the edge of the pan and the open end come above the surface of the soil underneath the pan. The pan is connected to the boiler by means of piping and heavy rubber hose. The boiler should have a capacity sufficient to discharge steam at 80 to 100 pounds pressure and the pan left in position for thirty minutes or longer. As a thermometer cannot be used while steaming to determine the temperature of the soil some other means may be used as a check. The old method of cooking a potato placed about four inches below the surface of the soil may be tried. When the pan is moved forward to a new position it should be placed so that it will slightly overlap the area already sterilized. It is advisable to cover the place that has been sterilized with tarpaulin or canvas for some time in order to retain the heat and secure better penetration. Care must also be taken when moving the pan that no dirt be carried from the unsterilized area to that which has been sterilized. A threshing engine that is in good condition may be used for sterilizing with the pan system.

2. **STEAM HARROW.** The steam harrow is shaped somewhat like an ordinary field harrow. It is composed of hollow iron cross pieces and hollow teeth about eight inches in length. At the lower end of each tooth is a small hole to allow the steam to escape. The whole harrow is covered with a heavy canvas so as to prevent the escape of steam. The teeth are forced to their full depth into the soil and the steam is passed into the cross bars from an attached pipe and escapes at the point of the teeth. As most of the steam escapes up the side of the teeth and does not penetrate the soil to any great extent, the steam harrow gives no better results than the inverted pan, hence this method has been discarded.

3. **STEAM PIPES.** A number of pipes having a diameter of $1\frac{1}{2}$ or 2 inches are used. A row of holes $\frac{1}{8}$ " diameter and 1" apart is drilled along one or both sides. These pipes are placed in the soil in parallel trenches about 18" apart, one end connected with a cross pipe which is joined to the steam line. The trenches are then filled in and steam passed through the pipes. This method, however, is not very satisfactory as the trenches have to be dug and the pipes changed before and after each steaming. The pipes may be left in the soil, but if this is done the holes are likely to become plugged and the pipes rusted.

4. **TILE.** In the larger greenhouses and where nematodes cause trouble, steaming through tile is the most satisfactory method of soil sterilization. The steaming should be done during the summer months as there is a much greater saving of fuel than when done during the winter months. It is also advisable to cover the area that is being steamed with tarpaulin, heavy paper or even bags or sacks in order that the steam may be held longer in the surface of the soil and not pass off so freely into the air. Such covering is required particularly during the winter months, otherwise it takes much longer to heat the surface of the soil.

Laying the Tile—Parallel trenches are dug and 3 or 4 inch tile are laid so that the top of the tile will be about 12 to 15 inches below the surface of the soil. They should be deep enough so that when the soil is being dug up there is no danger of breaking the tile. In some light open soils where nematodes are bad it may be advisable to place the tile a little deeper. The middle of the trenches may be from 18 inches to 2 feet apart, depending on the nature of the soil. If the soil is loose and open the tile may be placed deeper and a little farther apart than in soil of a heavier type. It is not advisable to have tile more than 2 feet apart in any soil. The ends of the tile should not be fitted together too closely, but left a short distance apart in order that the steam is free to escape at all joints. Small thin pieces of wood such as material used for making fruit baskets might be put between the tile to make sure they are not fitted too closely. A small amount of crushed stone or coarse gravel may be added at the joints as this will also assist in allowing the free escape of steam. If the tile are laid lengthwise in the greenhouse the outer rows should be laid close to the side walls and the ends of the rows should come close to the end walls, or a row of tile may be laid between the ends of the rows and the end wall of the greenhouse. It frequently happens that the soil around the walls or along the walks is not thoroughly sterilized.

Length of Rows—The length of the rows of tile depends to some extent on the capacity of the boiler to be used in steaming. Tile may be laid the length of the house and steam passed into one or two or more rows at a time. By fitting a "T" into the middle of a long row of tile the steam may enter through it and pass each way. Where a large boiler has been

used satisfactory results have been obtained in houses 300 feet long, two rows of tile being steamed at the same time. The steam entered at the middle of the row and passed 150 feet each way. When long rows of tile are used, the end farthest from the entrance of the steam should be fitted with a small pipe coming to the surface of the soil. This should be left open until the steam begins to escape freely, and then closed. This is particularly necessary in heavier types of soil in order to allow the cold air in the tile to escape and thus ensure a more even distribution of steam. In loose, open soils the cold air in the tile escapes more easily, hence it is not so necessary to have the far end of the tile fitted with a small pipe.

Although long rows of tile may be used, one end frequently heats up faster than the other, hence a loss of steam or a broken tile in the line will give trouble and will have to be replaced before the steaming can be completed. For these reasons it is preferable to have a number of short rows of tile coupled up in such a manner that the steam entering at one place can flow into the whole block at once. Thus in place of passing steam into one row of tile 300 feet long better results are obtained by passing steam into 10 rows each 30 feet long. If this system is followed a row of tile should be laid crosswise at both end of the rows and coupled up with the ends of each row. When steam enters this block of tile it will circulate throughout the whole block in a short time as it can enter freely at either end of the rows of tile. If there is a broken tile in any row the steam can enter at the other end of the row.

Steam Line to Tile—The tile may be connected to the steam line in different ways. By means of an elbow and two short pieces of 2-inch pipe an "L" shaped piece may be put together. One end of this is placed in the tile and the other end above the surface of the soil. A cap may be screwed on this end to keep the dirt out when not in use. If the steam is to enter at the middle of a long row then in place of an "L" a "T" may be used. Steam may be carried from the boiler to the tile through pipes used for heating, but it is much more satisfactory to run a direct line from the boiler using a 2 or 2½-inch pipe. The pipe may be connected with the piping in the soil by means of a jackknife structure and an ordinary union or by using a piece of heavy rubber hose.

Steaming—When starting to steam one should have on hand one or two good thermometers that will stand a temperature of over 212° F. (boiling point) and protected by a case so that they can be inserted in the soil. Such thermometers are expensive, but are necessary if one is to be sure of a thorough job and at the same time not waste time and fuel. A good dairy thermometer may be used, but it is not very satisfactory. The length of time required to sterilize any soil depends on the capacity of the boiler and the area that is being sterilized. The larger the area the longer it will take. One thousand square feet may be sterilized by a 100 H.P. boiler, but it will require a longer time than if a smaller area is being done.

Most of the organisms causing plant diseases are killed by steaming in a fairly short time, but a few such as fusarium wilt of tomatoes and nematodes are more difficult to control. If the tile have been properly laid and steam is escaping at all the joints the results ought to be satisfactory if steaming is continued for 30 minutes after the temperature of the soil between the rows of tiles has reached 200° F. Sometimes it is advisable to continue the steaming for an hour as there are often spots where the steam has not penetrated as rapidly as it has in most of the soil. When

the steam is shut off an opening should be left so that air can pass freely into the tile. If the opening is closed a suction develops as the steam within the tile condenses and this may cause wet soil or mud to be drawn into the tile.

Potting Soil—It is advisable to steam soil that is to be used for potting purposes as this kills insects, weed seeds and fungi that frequently cause "damping off" of plants when they are small. The soil may be sterilized either by the inverted pan or by tile or by building a box with pipes fitted on the bottom or lower part of the sides. On one side of the pipes there should be holes about $\frac{1}{8}$ inch in diameter and about 6 or 8 inches apart. The box is filled with soil, a tight-fitting lid put on and steam passed through the pipes. By using the box a more thorough job can be done and contamination is less likely to occur than with the other methods.

ACKNOWLEDGMENT

All of the photographs in this bulletin relating to the bacterial diseases were taken by Professor D. H. Jones, except where otherwise acknowledged. The descriptions of the bacterial diseases have been completely rewritten and others added. Grateful acknowledgment is made for the use of these photographs.

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BULLETIN No. 387

AUGUST, 1937

Ontario Department of Agriculture

SWINE DISEASES AND THEIR PREVENTION

by

R. A. McINTOSH, M., D. V., B. V. Sc.

SWINE FEEDING

by

R. G. KNOX, B. S. A.

FOREWORD

Freedom from disease and continued thriftiness throughout the growing period of a pig's life are the most important factors in determining whether those engaged in the production end of this industry reap a profit or experience a loss. Choice blood lines, model breed characteristics and good conformation mean but little if a pig is not healthy and vigorous.

The disease problem in swine is a serious one, particularly in the colder seasons of the year. Many of the diseases encountered have their origin in mismanagement or error in the care, housing and feeding of swine. For these reasons the Yorkshire Breeders' Club of Ontario requested the Department of Agriculture to have a bulletin prepared covering the more common ailments of swine and the manner in which they can be prevented. The sponsorship and publication of this bulletin has been done with the hope that all those interested in swine production will be guided by the suggestions contained herein.

SWINE DISEASES AND THEIR PREVENTION

by

R A. McINTOSH, M., D. V., B. V. Sc.

In the preparation of this bulletin it is felt that it would be advisable first to reveal the various diseases of swine from the time of birth until they are of marketable age, and subsequently to outline the procedure which should be followed for the prevention of these ailments.

The purpose of arranging the bulletin in this form is to impress the swine raiser of the necessity for the continued application of preventive measures from the time the pigs are born until they are ready for market. Neglect of the sow during pregnancy will be reflected in the newborn. Lack of attention while in the suckling stage will lead to trouble at weaning time. Improper feeding in the weaning stage will be followed by poor growth and development in the feeding stage, which in turn leads to disappointment when finishing the pigs off for market. There is a relationship between the care that pigs receive during these several stages of their growth and the diseases which may occur. Some of these ailments come on gradually and insidiously and are not easily observed until the animals are obviously sick. The wise pigman anticipates this and does not wait until the pigs are sick. He avoids loss by the practice of prevention throughout his pig-raising programme.

GOITRE OR HAIRLESSNESS OF THE NEW-BORN

The term goitre is applied to an enlargement of the thyroid gland. This gland regulates the utilization of food products as they are carried to the tissues of the body and also the elimination of waste products. The normal functioning of the gland is dependent upon a sufficient amount of iodine being present in the body. The gland commences to function before the little pigs are born, and if the pregnant mother should be lacking in iodine, the thyroid glands of the developing litter will also suffer. When this happens, the little pigs are born without hair, the skin is puffy, the neck thick, and they are often born dead. Those that are born alive usually die within a day or two after birth.

This condition occurs with relative frequency in certain parts of the country and more often in winter litters. It can be effectually prevented by the provision of iodized salt to the pregnant animal and will be referred to in the synopsis on prevention.

ANEMIA OF SUCKLING PIGS

Anemia may be looked upon as an excessive watery condition of the blood. The blood is deficient in its solid constituents, its cellular content and its red colouring matter. To enable a realization of the importance of the blood an explanation of some of its functions in the body would be of value. First, it is the means by which nutrient substances are carried to the tissues. Second, it carries oxygen from the lungs to the tissues. Third, it removes waste products from the tissues and carries them to the organs of excretion. Fourth, it assists in maintaining the level of the body temperature. Fifth, it assists in the body defences against infection.

Anemia of suckling pigs occurs because of a deficiency in iron, one of the important elements found in the red colouring matter of blood. Ordin-

arily little pigs get their iron from the ground and other material they may eat. During the colder seasons of the year, however, they are generally kept penned in rather small quarters, often on cement floors, and they tend to remain hived in the bed. If there is no soil or other material in the pen for them to eat and root in they do not get any iron, neither is there a sufficient amount in their mother's milk to meet with their requirements. Strong young litters of pigs grow very rapidly and the need of iron (on those occasions when it is deficient) commences at about the end of their first week of age. If preventive measures are not taken, they will be badly affected by the time they are three or four weeks old. Normally, little pigs of the white breeds have a pink skin. Their bristles are bright, shiny, and smooth and they are playful, but when they become anemic they do not thrive, their skin becomes a pasty white, the bristles lose their lustre and commence to curl. At this stage, because of an impoverished blood stream, they are much more susceptible to other diseases, and as a result scours often occur or lung trouble with coughing and pneumonia. The symptoms described apply to any breed of swine, but are more obvious in the white pig. Once the little pigs commence to eat there is no danger of a lack of iron. The dangerous and critical period is in the first four weeks of their lives. Anemia can be prevented and is dealt with later in this bulletin.

CONVULSIONS, STIFF SICKNESS AND CRIPPLING

One of the most critical times in the life of a young pig follows weaning. Until they are weaned their chief article of diet has been their mother's milk. This, of course, is the ideal food for them, providing the mother has been properly fed. As soon as they are weaned, however, they are often provided with a ration which is too coarse, rough and deficient in certain elements of food which they require at this period. There are two elements they need particularly at this time, that is, calcium and phosphorus. These have much to do with the normal growth and development of the bones and other tissues of the body. They are also essential for the normal functioning of the nerves, the blood stream, the muscles of the intestines, and the digestion and assimilation of food. In addition to it being necessary that the food provided for them contains these elements in adequate amounts, it is also essential that the rations contain other factors necessary for the utilization of these minerals. These factors are known as Vitamines A and D, and particularly the latter.

If the food provided for the pigs is lacking in calcium or the vitamin factor, certain symptoms are frequently observed. First, it may be noticed that the pigs tend to remain hived in the bed and when they are fed they may rush up to the trough, take a bite or two, and then go into a convulsion or fit. Sometimes they will die in the fit, but usually it passes off. Later on it may be noticed that some of the pigs are becoming stiff and are reluctant about coming to the trough to feed. They squeal with pain and in time they grow worse and finally become so crippled they will not move unless forced to do so. The joints may swell and in some instances the legs become crooked as in rickets. In reality it is a true rachitic disease. This condition usually comes on about four weeks after weaning and until they are four or five months old. In the majority of cases this

is the reason for crippling although on occasions it may have other causes. It is purely a deficiency disease and like some of the other conditions mentioned, lowers the defensive powers of the body so that they become the prey of intestinal disorders and lung troubles.

ROUND WORM INFESTATION

The period from a few weeks to 3 or 4 months is also a dangerous period as far as the large intestinal worms are concerned. If the pens and yards have been seeded down with the eggs of this parasite, the likelihood of young pigs becoming infested is very great. They will get the eggs while nursing their mothers or when rooting and playing about in the pen. When the eggs of the worm are swallowed they pass into the intestines and hatch. The young worms then pass through the wall of the gut, gain entrance to the blood stream, then pass through the liver and on into the lungs. Finally they get into the bronchial tubes and windpipe, out of which they crawl, or are coughed up and re-swallowed. In the intestine they grow into the large round worm which is so frequently seen in pigs. It takes about ten to forty days for this to occur and if heavily infested certain symptoms are shown. They go off their feed, vomit, are unthrifty, cough, have thumps, and may develop a pneumonia. If the pig passes this stage successfully the worms develop rapidly in the intestine and interfere with the digestion and assimilation of food and the pig becomes stunted in its growth. Sometimes they are so numerous in the intestine as to cause blockage. On occasions they crawl up into the bile ducts of the liver. The degree of damage will depend upon their numbers. A few will not affect the pig noticeably, but large numbers always do. After pigs are three or four months old, the danger is not so great. It is while the pigs are infested with the adult parasite in the intestine that the eggs are given off and the pens become infected. These eggs live a long time in the soil and dirt about the pens and will reinfect pigs that may be already there and other litters which come along later, unless something is done to destroy them.

Anyone reading this bulletin will have noticed that nothing has been said about infectious diseases caused by germs thus far. This has been done deliberately for the purpose of impressing the fact that the foregoing ailments are the primary ones and render these young pigs susceptible to the infections. If they are properly housed, cared for, and adequately fed the likelihood of some infectious disease occurring is reduced to a minimum and the need of bacterins, serums, and such like surmounted.

THE INFECTIOUS DISEASES

There are a number of infectious diseases which affect swine. There is an intestinal infection which causes inflammation and ulceration of the lining membrane of the gut. Before this occurs, however, it invariably requires some predisposing influence such as coarse food, filth, dirt, overstocking, chilling and exposure. The germ which causes this is known as the *Salmonella suispestifer* and when it produces disease in the intestine fever, diarrhea and loss of appetite occur. The affected animal may die in a few days or if it continues to live the condition becomes chronic and the pig remains unthrifty.

Another infectious disease of pigs is Swine Influenza and like influenza of human beings is first manifested by fever, coughing, and difficult breathing, due to swollen nostrils. Later on the bronchial tubes and lungs may become involved. This disease is not thought to be very common in Canada, although undoubtedly some outbreaks have occurred.

Swine Erysipelas is an infectious disease which occurs on occasions. It is, however, essentially a warm weather disease. Most outbreaks occur during the summer. Pigs under three or four months of age seldom contract the infection. It appears in three forms; namely: acute, subacute, and chronic. In the acute form the affected animal develops a high temperature and as a rule dies in a relatively short time after having been noticed sick. In the subacute form the affected animals are not so sick and it is characterized by the appearance of red blotches on the skin easily observed in white pigs. These blotches will appear on the sides and over the back. Only an occasional pig will die with this form of the disease and they tend to recover in the course of a few days. In the chronic form of the disease, the joints of the animal become affected and they go stiff and lame. Pigs so affected seldom ever recover from the stiffness. Fortunately this type of the disease is rather uncommon.

HEMORRHAGIC SEPTICEMIA

This disease is commonly known as Shipping Fever, chiefly because the most serious outbreaks of it occur following transit on railroad cars and in trucking. It may, however, occur when predisposing influences other than shipping obtain. It is an influenza-like disease in that it comes on rather suddenly, causes a fever and is associated with coughing, bronchial trouble and pneumonia. The symptoms are very much the same as those seen in other bronchial and pneumonic diseases and undoubtedly it has been diagnosed on many occasions when it did not exist.

The germ which causes it is known to be present in the nasal passage and bronchial tubes of normal animals. It invariably requires some circumstance which reduces the animal's disease resisting powers before the disease occurs. In this regard shipping, excessively humid weather or stabling quarters, dull weather, improper feeding and a lack of sanitation in the pens play a part. It should be remembered that these predisposing influences are just as important as the germ itself in the occurrence of this disease.

On occasions animals surviving an acute attack become chronically affected and continue to cough although not otherwise seriously ailing. Such animals are a source of danger to other young pigs which may be raised on the same premises. Serious outbreaks have occurred in young lots of pigs where a carrier pig has been allowed to mingle with them. It is quite possible to purchase a carrier pig for breeding purposes and in this way innocently introduce the infection into a healthy herd. This is more or less true of many of these infections. The greater the sale and exchange of animals, the greater the likelihood of the dissemination and spread of these diseases. Hemorrhagic Septicemia may occur at any time of the year but is most prevalent in changeable weather during the fall and spring.

THE PREVENTION OF DISEASE

The successful rearing of pigs embodies a number of features. First, suitable housing facilities; second, sanitary measures; and third, a thoughtful consideration of the diet requirements throughout the growing periods.

During the summer months and on into fall, housing requirements are not so important since a colony house, a portable paddock, and a bit of clean ground in which to raise a litter of pigs are easily provided. In the winter and early spring, however, it becomes necessary to provide suitable farrowing pens and housing. The main requirements are plenty of light, proper drainage, ventilation and warmth. One of the most objectionable features of pig houses is that they tend to become excessively humid and damp, particularly if an attempt is made to raise too many pigs for the size of the quarters. Pigs will stand quite a lot of cold if the quarters are dry and plenty of bedding is provided, but dampness and cold combined are conducive to disease. Sanitary measures have reference to cleanliness and antiseptic precautions.

THE IMPORTANCE OF SANITATION

The features which operate against proper sanitation in the housing of pigs are poor drainage, bad ventilation, inadequate lighting, accumulations of filth and manure in the pen, and overstocking. These undesirable conditions can be overcome by correcting them and keeping the pens clean, dry and disinfected. The danger of overstocking is a serious one for, when pigs are crowded in their quarters, the possibility of keeping the air fresh, the pens clean and avoiding excessive dampness is greatly lessened. Furthermore, the likelihood of disease occurring is correspondingly increased. It is much better to raise fewer pigs successfully than to exceed the housing capacity by raising too many and run the risk of serious losses.

MANGE AND LICE

The lack of sanitation and cleanliness mentioned in the foregoing paragraph also favours external parasite infestation, such as mange and lice. The mange mite causes intense itching, inflammation of the skin, the formation of scabs and unthriftiness. Lice also cause itching and skin trouble. These parasites are always more prevalent during the colder seasons of the year. Whenever pigs are observed scratching and rubbing excessively they should be examined for parasites. Lice can be seen with the naked eye but mange mites are so small that it requires a microscopic examination of scrapings from the skin to determine their presence. However, if the pigs are intensely itchy, and scabs are forming on the skin, mange is the most probable cause of the trouble. Mange infestation and lousiness can be prevented by cleanliness and disinfection. Periodical examinations of the pigs should be conducted during the winter and if there is any evidence of parasites, smearing the skin of the body with used crank-case oil is an effectual way of ridding the pig of these pests. Mineral oil or linseed oil are also effectual. A paint brush may be used to apply the oil and while it should be smeared all over the body, particular attention should be given to the snouts, around the base of the ears and in between the legs.

THE CARE OF THE PREGNANT SOW

In a swine raising programme the first thing to take into consideration is the selection of sound and healthy breeding stock. Sires whose breeding efficiency is known should be selected and a similar consideration should be given to the motherhood characteristics of the dam. The second feature is the management of the pregnant animal. Too often after the brood sow has conceived, she is completely neglected and allowed to shift for herself. The main requirements are exercise, shelter and feeding. Most care and consideration in the feeding of the sow is required when she is pregnant and while nursing her young. During these times she has placed upon her the burden of the development of the litter and the provision of milk for their growth. During the first half of the pregnancy period, fattening foods should be avoided and it is not desirable that she should be excessively fat at any time, but she should be fed adequately and with a ration sufficiently varied in character to supply the demands of the developing litter within her. It should be remembered that the health and well-being of the pregnant sow is reflected in the vitality and vigour of her newborn.

During the summer, when sunshine and green food are available, a suitable pasture is the ideal place for a pregnant sow. By rooting she will obtain material from the soil which is stored for future body needs. In the winter, however, these materials are not available in this way and must be provided in the form of good quality alfalfa or clover hay or roots and a little oilcake in addition to her regular grain ration. Near the farrowing time the bulk of the ration should be reduced and her diet made more laxative. A little linseed oil added to the meal will be of value in this regard.

PREVENTION OF HAIRLESS PIGS

It is during pregnancy that hairlessness must be prevented. Dissolve 1 ounce of potassium iodide in 1 gallon of water and give the sow a tablespoonful of the solution once a day. It can also be prevented by mixing 1 part of iodized salt in 100 parts of the meal being fed. Iodized salt may be made by mixing thoroughly 1 ounce of potassium iodide with 300 pounds of bulk salt.

Prior to farrowing the pen should be thoroughly cleaned out and washed down with scalding hot water and lye. One tin of lye is added to thirty gallons of water. This will destroy parasite eggs. The pen should be clean, dry and warm. The sow's udder and teats should be washed clean and dried off.

PREVENTION OF ANEMIA

After the litter is born, the first disease condition for which to be on guard is anemia and to prevent this the feeding of iron should commence by the time the pigs are a week old. For this purpose reduced iron or granular iron sulphate may be used. It must be given to the little pigs individually. It only requires a small amount for each pig twice a week until they are about four weeks old, or have commenced to eat. The dose

required is about the equivalent of the amount that can be picked up on a small Canadian five-cent piece. A small mustard spoon makes a suitable instrument to give it with and the iron should be put on the tongue. Dosing them individually may be avoided if a few sods are put in the pen. To insure the presence of iron in the sods they may be sprinkled with a solution of iron sulphate. The solution is made by dissolving a teaspoonful of iron sulphate in a quart of water. If the pen is warm enough the little pigs will root and play in this dirt and apparently get enough iron to prevent anemia. It would probably be advisable to have the sods placed in a creep or a crate away from the sow. The sods should be renewed twice a week. A supply of sods should be stored before winter sets in.

If the little pigs should scour while nursing, change the mother's diet at once and feed her nothing but shorts and lime water until the little pigs are better. During this time keep the pen warm. Subsequently the sow may be gradually returned to her regular ration. Lime water can be conveniently made by placing a half a pound of slaked lime in a 5 gallon can, add 1 quart of water, stir, and allow the lime to settle. Pour off the water and discard, leaving the lime in the bottom of the can. Fill the can with clean water, stir, and allow the lime to settle again. Use the water off the top of the can without disturbing the lime at the bottom.

Before the pigs are weaned they should have the opportunity to eat of the meal mixture they will receive after weaning. By so doing their digestive organs will have become accustomed to coarser foods and the change from their mother's milk to the regular ration will have been attained gradually.

Throughout this bulletin repeated reference has been made to the relation that improper feeding has to the occurrence of disease, and at this stage the writer again emphasizes the importance of providing suitable rations for the weanling pigs. In this regard, to assist those interested, there is included in this bulletin a list of suitable rations for swine of all ages. These have been compiled by Prof. R. G. Knox of the Ontario Agricultural College, and while they need not necessarily be followed to the letter, they will serve as a guide in formulating rations for pigs at various ages and times depending upon the purpose for which they are being raised.

PREVENTION OF CRIPPLING

The cost of feeding young pigs when they are just weaned is not great, but it is very important that they are adequately and properly fed at this time. It is cheap insurance. Later on when they get some size and age coarser and cheaper feeds may be fed more safely. The meal provided for weanling pigs should be easily digestible and of the nature suggested in the first formula—for pigs just weaned. During the winter it is also advisable to give some concentrated cod liver oil along with the feed. If a reliable oil is used it will insure the presence of Vitamins A and D, which are so important in the growth and health of these young pigs. At weaning time a teaspoonful for each pig once a day is sufficient but it should be increased up to a tablespoonful per day by the time the pig is

four months old. In the summer time when pigs can be raised out in the open and on pasturage the oil is not needed. These vitamins are also important in the prevention of disease because they keep the lining membranes of the stomach and intestines and the bronchial tubes and lungs in a healthy state.

THE QUESTION OF ROUND WORM INFESTATION

In the summer have the sows farrow in a colony house on pasture which has not been frequented by pigs for some time at least. In the winter wash out the farrowing pen with scalding hot water and lye. White-wash the pen and keep it clean. If there is any indication of worms give 1 fluid drachm of oil of wormseed in 2 fluid ounces of castor oil for a pig weighing 100 pounds. Smaller amounts of the medicine will suffice for smaller pigs and somewhat larger amounts will be required for larger pigs. The animals should be starved for 24 hours before dosing. A sloppy mash may be given 2 or 3 hours after dosing. Permanent exercising yards connected with the pig houses are liable to become badly infested with worm eggs and it would be much better to have a relatively large place for them to run in and to have it divided so that one pen could be used one year and the other the following year. These yards should be large enough to permit plowing and seeding down.

PREVENTION OF INFECTIOUS DISEASES

Mention has been made of an Infectious Enteritis which causes an inflammation and ulceration of the intestines, of Swine Influenza, Erysipelas and Hemorrhagic Septicemia. It is often quite difficult, even for those experienced in the diagnosis of swine diseases to differentiate between some of these conditions, and before specific measures of control can be intelligently put into effect it is necessary that a proper diagnosis be made.

There are, however, certain regulations which are more or less applicable for the prevention of these infectious diseases. If young pigs are properly fed and cared for and a reasonable degree of cleanliness and sanitation maintained in their pens until they are four months old, the likelihood of any of these infections occurring is greatly reduced. In the event of one or more pigs in a lot showing signs of sickness they should at once be placed in another pen separate from the healthy ones. This should always be done regardless of the nature of the disease. A veterinarian should be consulted and given the opportunity to examine the sick animals and look over the contact pigs. The owner should be guided by his advice and if any vaccination product is required, the veterinarian should make the selection of it and administer it. In isolating sick pigs it is always advisable to select the warmest available pen, cut down the bulk of their rations and keep them on liquids and laxatives.

It is timely to warn against the promiscuous use of vaccines and vaccination products. Too much reliance is placed upon them. The feeling seems to exist that a hypodermic syringe and an injection of something under the skin is a panacea for all of the ills of swine. The intelligent and

proper use of some of these products have their place but if anyone uses them for the cure of anemia or rickets or worm infestation, he will surely be disappointed. Even on those occasions where there are definite indications for the use of a vaccination product, its use should be supplemented by improving the diet, sanitation and comfort of the animals. What has been written about the promiscuous use of vaccines also applies to the use of condition powders. There are occasions when these may be used to advantage, but they should be prepared in accordance with the requirements of the diseased animals. It should be remembered, however, that they will not take the place of proper food, neither will they correct conditions resulting from overcrowding and pens not kept clean.

Young pigs which anyone anticipates putting in a show circuit should be inoculated to protect them against Hemorrhagic Septicemia. This should be done two weeks prior to shipment. While on the circuit over-feeding should be guarded against and a meal slightly more laxative than usual should be provided. A teaspoonful of common baking soda in the feed for each pig is of value in this regard and tends to maintain the normal alkalinity of the bloodstream.

The concluding pages of this booklet are devoted to representative formulae for feeding swine from the time they are weaned until they become adults. There are also hints for the modification and supplementation of these rations. It is suggested that those interested should study this phase of their swine raising program carefully and be guided by the information contained therein.

SWINE FEEDING

By R. G. Knox, B.S.A., Professor of Animal Husbandry

BASAL FEEDS

Of the cereal grains grown in quantity in Ontario barley, wheat and oats stand out as being the most suitable for the production of quality bacon. Corn is considered the standard hog feed in the United States, but in Canada is grown only in limited quantities. It may, however, be fed advantageously to fattening hogs and even to growing pigs, if a sufficient amount of protein is added to bring the ration up to the necessary protein level. Hominy meal, a milling by-product of corn, is similar in its feeding value.

It does not necessarily follow that the grains mentioned are the only ones which may be used in swine feeding. Other farm grains may be fed in limited quantities in combination with those mentioned to good advantage. In all instances better results will be obtained from feeding the ground grain than from the whole grain. The milling by-products of wheat (bran middlings and shorts) may also be fed to good advantage in rations for specific purposes. Bran fed along with cereal grains to the

nursing brood sow helps to keep the bowels in a more laxative condition and stimulates milk production. Middlings and shorts may also be fed to nursing sows with good results if fed in combination with other cereals and the same may be said in connection with the feeding of weanling pigs.

PROTEIN SUPPLEMENTS

Dairy by-products are unquestionably the most satisfactory sources of protein with which to balance the ration for a bacon hog. They are rich in protein and the protein in turn is rich in the amino acids which are not plentiful in grains. In addition, dairy by-products are rich in minerals particularly calcium and phosphorus. There is little difference between the feeding values of skim-milk and buttermilk. Whey has only half the feeding value of buttermilk or skim-milk and should be supplemented with some other protein-rich feed for the young growing pig. If these dairy by-products are not available tankage, meat meal, fishmeal, oilcake or soya bean oilmeal may be advantageously used to bring about the necessary protein level for whatever age or class of pig that is being fed. Of the protein feeds just mentioned, combinations of two or more of them make for greater variety and give better results than any of them fed singly, although tankage as a sole protein supplement will give good results.

Vegetable proteins are not as readily assimilated by the hog as are animal proteins, but if fed along with animal proteins have a higher digestible co-efficient, hence the wisdom of combining proteins from both sources. Moreover the ash of vegetable protein rich foods is not so well balanced, which further emphasizes the value of variety.

In addition to protein supplements, the value of green food and roots is recognized because of their succulence, variety, vitamin and ash content. Alfalfa meal, because of its protein-mineral-vitamin content is also a useful supplement and may be added to the basal ration in from 5 per cent to 20 per cent amounts, depending upon the class and size of the pig being fed.

The following protein levels in hog rations will give satisfactory results:

Newly weaned pigs	18-22% protein
Pigs weighing 60-125 lbs.	14-16% protein
Pigs weighing over 125 lbs.	12-14% protein
Mature breeding stock	10% protein
Nursing sows	14-16% protein

The following Protein-Mineral Supplement may be used to advantage where dairy by-products are not available:

Tankage (60% protein)	500 lbs.
Fishmeal (not over 6% oil)	150 lbs.
Linseed oilmeal	230 lbs.
Salt (Iodized 3 ozs. per cwt.)	50 lbs.
Bonemeal	50 lbs.
Cod Liver Oil	20 lbs.

AN OUTLINE OF SUGGESTED RATIONS

FOR SPRING AND SUMMER FEEDING

Pigs, just weaned, up to 70 lbs.

Middlings	50 lbs.
Oats	50 lbs.
Skimmilk or Buttermilk	250 lbs.
or	
Protein-Mineral Supp.	15 lbs.
Grain must be ground medium fine.	
Remove oat hulls by screening through ordinary fanning mill, turning it in reverse direction.	

Growing Pigs 70 to 110 lbs.

Middlings	25 lbs.
Oats	50 lbs.
Barley	25 lbs.
Skimmilk or Buttermilk	200 lbs.
or	
Protein-Mineral Supp.	10 lbs.
Pasture such as rape, clover, or alfalfa will reduce grain requirement by about one-third.	

Growing Pigs 110 to 160 lbs.

Oats	40 lbs.
Barley (or barley 30, wheat 30)	60 lbs.
Skimmilk or Buttermilk	150 lbs.
or	
Whey	300 lbs.
or	
Protein-Mineral Supp.	9 lbs.

Finishing Pigs for Market

(a) Oats	30 lbs.
Barley	70 lbs.
Protein-Mineral Supp.	4 lbs.
(b) Oats	30 lbs.
Corn	70 lbs.
Protein-Mineral Supp.	8 lbs.
(c) Oats	30 lbs.
Barley	35 lbs.
Wheat	35 lbs.
Protein-Mineral Supp.	4 lbs.

NOTE: Corn may be substituted for barley, but if this is done the amount of Protein-Mineral Supplement should be increased slightly. If milk is available Protein-Mineral Supplement may be eliminated.

FOR FALL AND WINTER FEEDING

Sows When Dry

In summer use pasture, and if sow is in thin condition feed 1 lb. grain per 100 lbs. live weight.

In winter feed choice quality alfalfa or clover hay and roots, with a mixture of equal parts oats, barley, and middlings.

Feed milk or 4 to 8 pounds Protein-Mineral Supplement per 100 lbs. grain for 6 weeks before farrowing.

Add 3 lbs. oilcake meal per 100 lbs. grain if no roots are fed.

Mature Boars

Oats	50 lbs.
Barley	50 lbs.
Protein-Mineral Supp.	10 lbs.
or	
Skimmilk or Buttermilk	150 lbs.
or	
Whey	300 lbs.
Feed 2 lbs. roots per 100 lbs. live weight in winter, or pasture in summer.	

Use same rations as for spring and summer feeding and add 2 lbs. roots per 100 lbs. live weight of hog per day.

Alfalfa hay of choice quality may be fed in racks to pigs over 100 lbs.

3 lbs. oilcake meal per 100 lbs. grain may be added for weaned pigs, especially if no roots are fed.

Sows When Suckling Pigs

Oats	35 lbs.
Barley	35 lbs.
Middlings	30 lbs.
Skimmilk or Buttermilk	220 lbs.
or	
Protein-Mineral Supp.	15 lbs.
Roots, daily, approx.	7 lbs.

Minerals for Swine

Feed 2 pounds of feeding bonemeal and 1 pound of salt in every 100 pounds of grain for all swine except when the protein-mineral supplement is fed.

BULLETIN 388

AUGUST, 1937

Ontario Department of Agriculture

Vegetable Gardening

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Vegetable Garden — York County

PLANNING THE VEGETABLE GARDEN

A definite plan of a garden prepared a considerable time previous to planting affords advantages. A fresh supply of all vegetables, when desired in quantities meeting the demands of each member of the family, is provided. With a plan as a basis of consideration the correct amounts of seeds and fertilizers may be ordered in advance to avoid any absence or duplication of these commodities at planting. Economy of space in the garden and time at planting are effected by carefully allotting, previous to planting, the exact space and planting distances for each vegetable. Provision for a continuous vegetable supply is made by provision for space at the correct time for each successional planting of any particular kind or variety.

30"	Cord with Squash and Pumpkins		
24"	Staked Tomatoes - 20 plants		
36"	Cucumbers - 5 hills Summer Squash - 1 hill		
12"	First Early Lettuce and Radishes		
12"	Early Cabbage followed by Spinach or Turnips		
20"	Bush Beans mid season	Followed by Late Cabbage " Lettuce " Cauliflower	25'
20"	Peas		
20"	Bush Beans early		
10"	Spinach "		
16"	Onion Sets "		
16"	Beets (transplanted or sown early)		
16"	Carrots		
16"	Carrots	Parsnips	
16"	Beets for winter use		
20"	Celery		

Plan for a small home garden 40 ft. by 25 ft.

A study of these two garden plans demonstrates that close planting and intensive cultivating implements, such as the wheel-hoe, are used in the small home backyard garden; whereas the more extensive space afforded by the farm home garden permits wide distances between rows and turning distance at ends of rows for horse or tractor drawn implements. Quick maturing crops should follow one another in successive rows to afford planting of later crops after harvesting the early crop. Perennial crops should be at one side of the garden to permit plowing and other continuous cultivation.

SUCCESSION CROPPING

Succession cropping is the growing of two or more crops on the same land in one growing season. These plantings are not confined to one vegetable crop. One kind of vegetable may immediately follow a different kind of vegetable on the same soil. Sometimes three different crops are grown in succession. This cropping demands well fertilized land and efficient cultural practices. The length of the growing season and the nature of the crops grown control the number of crops capable of being produced.

[illegible]

Plan for a farm home garden 200 ft. by 112 ft. The rows are spaced to permit of horse cultivation.

Succession cropping examples consist of:

Lettuce followed by late celery, especially on muck soil.

Radish or lettuce following by late cabbage, parsnip or spinach.

INTER-CROPPING OR COMPANION-CROPPING

This system is conducted when two or more crops are grown on the same soil at the same time. Crops which mature at different dates are sown or planted at the same time. The first maturing crop, usually a small-growing quick-maturing crop is harvested, and then the later larger slower-growing crop is allowed sufficient space and time to reach maturity.

Economy of space and of cultivation; increased revenue and more complete use of plant-food, are effected. However, intensive inter-cropping demands a large amount of labour, and usually prevents the use of large implements. With this cropping system the habit of growth, the space required by each crop, and the time required to reach marketing condition are to be considered. Large quantities of manure and fertilizers are requisite to have the plants well fed for efficient growing conditions.

Examples of this system are:

Two rows lettuce or spinach between cabbage.

Early lettuce or radish and beets about twelve inches apart.

CROP ROTATION

Crop rotation applicable to crop production is the systematic arrangement of the growing of different crops in a regular sequence on the same land over a period of two, three or more years.

The more important advantages provided by rotation of vegetable crops are:

The control of plant diseases and insects is aided.

The drain on the supply of raw materials in the soil tends to be equalized.

The plant food supplied to the soil is used with greater efficiency.

In planning a rotation one should consider the following recommendations:

Allow as much time as practicable for the production of soil improving crops.

Following crops which furnish organic matter with those which favour its rapid decomposition.

Alternate deep-rooted with shallow-rooted crops.

Vary the crops in rotation in respect to the kinds and amounts of plant foods required, character of root growth and time of year at which they occupy the soil.

THE SOIL

With few exceptions vegetable crops always prefer soil types that range from light clay loams to light, sandy loams and well decomposed mucks. Within the whole range of variety of vegetable crops certain crops are especially adapted to a particular type of soil, while other crops will grow successfully on any one of the soil types mentioned. However, as the soil is the prime requisite in successful vegetable crop production, it behooves the grower to understand the physical and chemical characteristics of not only the surface soil but the subsoil as it influences the retention of plant food nutrients and water holding capacity of the soil.

Lack of space forbids an exhaustive discourse on the physical and chemical characteristics of each soil type. Therefore, only a brief discussion will be given of the more important chemical and physical characteristics. Anyone wishing to make a further study will find any good text book on soils very helpful.

Light Clay Loams—Physical characteristics consist of approximately 20 — 30 percent clay, 30 — 50 percent silt and 20 — 50 percent sand. This soil type has a high water holding capacity, is retentive of plant food added but rather difficult to work when wet owing to sticky nature, and a tendency to bake and crack in dry weather. It is generally rich in potash and phosphoric acid and under good management the organic matter content will be quite good and, consequently, it will be rich in nitrogen.

Heavy Sandy Loams—Physical characteristics consist of approximately 20 — 30 percent clay, 10 — 20 percent silt and 50 — 70 percent sand. This type of soil is easy to work even when quite wet and will not become very sticky. When dry it will not bake or crack. It is fairly retentive of moisture and plant food and is suitable to a very wide range of vegetable crops. It is naturally fairly well provided with potash and phosphoric acid, though not quite so much as the light clay loams. The nitrogen content will vary directly with the organic matter content. In general, owing to the open nature of this soil it will be slightly more difficult to maintain as high a standard of natural fertility as in the light clay loams, but what is present will be in a more active form.

Light Sandy Loams—Physical characteristics consist of approximately 5 — 10 percent clay, 5 — 15 percent silt and 75 — 90 percent sand of various sized particles. This type of soil is very open in nature. is not very retentive of plant food constituents and has a low water holding capacity. Consequently, whatever plant food is added either in the form of manures or fertilizers will soon disappear if not consumed by the growing plant. Providing it is properly nourished this type of soil is very suitable for vegetable growing, especially for very early crops. It can be worked very early in the spring and growth commences quite early as it is well drained and warms up quickly.

This soil type is usually very low in nitrogen, phosphoric acid and potassium and responds quite readily to applications of complete fertilizers and organic manures.

Mucks—These are well decomposed peat soils and are formed by the accumulation of large amounts of organic matter in shallow lakes or ponds over a long period of time. The composition of muck soils varies, depending on how much mineral matter may be present by erosion from higher ground. Consequently, the soil may contain from 35 to as much as 95 percent organic matter, the remainder consisting of mineral constituents such as sand, clay and silt. Muck soils become of extreme value for market garden crops when drained and are especially adapted to the growing of such crops as onions, celery and lettuce.

Muck soils are extremely rich in nitrogen but often light applications of quickly available nitrogen are profitable as the organic nitrogen is too slowly available for quick growing crops. As the percentage of mineral constituents is very small they are very low in phosphoric acid and potassium, hence fertilizers containing high percentages of these constituents should be used.

IMPORTANCE OF THE SUBSOIL—Very often the top soil appears to be ideally suited for the production of vegetables but often results prove to be very disappointing and in a large number of instances examination of the subsoil will reveal quite

unexpected conditions, such as a layer of heavy clay, hard pan or quick sand, giving rise to poor drainage, a cold wet subsoil or one which dries out very quickly. The darkness of the surface soil indicates the amount of organic matter it contains and is a direct measure of suitability of the soil for retaining moisture and bacterial activity. If the colour of the subsoil is reddish yellow it indicates good drainage conditions and air circulation in the soil which is absolutely essential for bacterial activity and root development. If, however, the colour is gray-blue, slate colour or mottled, or a hard pan formed, indications are that some form of drainage and sub-soiling would be highly beneficial.

TOPOGRAPHY—In selecting sites for market gardening purposes the topography of the soil is quite important. Sites with a gentle slope towards the south will aid materially in providing natural drainage and the production of earlier crops. Steep hillsides should be avoided for reasons of difficulty in cultivation operations and erosion of soil during periods of heavy rainfall. If, in selecting the site, it is possible to include a variety of soil types and conditions varying from heavy loams to light sands and mucks the grower is very fortunate as this will enable him to grow a wide variety of crops on the particular soil to which they are best adapted.

SOIL PREPARATION—Well prepared soil is one of the main factors for success with vegetable crops. Thorough preparation may begin with drainage by providing both under and surface drainage if necessary. Deep plowing, in order to give as deep a layer of soil as possible to the feeding roots, is advised. Fall plowing is usually best owing to the action of frost and the earlier date that seeding may be done. This is very important for some crops. Spring plowing should be done as early as possible yet the soil should be dry so that no lumps are formed. Cover crops, such as Rye or Clover, are usually left over winter and plowed down in the spring. Early seeding and planting are best done on fall plowed land. Thorough disking and harrowing followed by rolling if soil is lumpy, and finishing up with a fine smoothing harrow like the Meeker harrow, will produce a fine seed bed. Extra working of soil at this time helps to warm the soil and render more plant food available to the crop. Some soils may become very lumpy and require rolling or the plank drag in order to produce a fine seed bed. Some muck soils are so loose and open that planking and rolling are necessary to compact or firm it before seeding or planting can be done satisfactorily.

SEED

Good seed is necessary for the production of maximum crops. Old seed, unless tested for germination and type, only leads to disappointment. Use only fresh large seed of high germination percentage which is clean, true to type, and of uniform size. The best grade of seed obtainable from reliable seed houses should be used. The extra charge for good seed is made up many times over in the resultant crops. It frequently pays to make a germination test of the seed, especially if the seed is known to be old and still desired owing to its proved type. As a rule, however, seed sold by good dealers will germinate satisfactorily. A test for germination may be easily made by counting out a certain number of seeds, placing these between two thick blotting papers, which are kept moist in a covered dish in a fairly warm room. This usually requires a few days to be sure of all good seeds sprouting. A count of number of seeds sprouted per hundred will give the percentage of germination.

Seeds kept in storage are best stored in mouse-proof boxes or cupboards where extremes of moisture and dryness and extremes of heat and cold can be avoided.

Constant even moisture as well as even temperature, aid in retaining the vitality of stored seeds. Vegetable seeds vary as to normal length of time they retain vitality enough for crop production.

The following table gives the time the various seeds retain germinating strength under good storage conditions.

TABLE OF VITALITY OF VEGETABLE SEEDS

Vegetable	Years	Vegetable	Years	Vegetable	Years
Asparagus	3	Kale	4	Pumpkin	4
Bean	3	Lettuce	5	Radish	4
Beet	4	Muskmelon	5	Salsify	1
Cabbage	4	Okra	3	Spinach	4
Carrot	2	Onion	2	Squash	4
Cauliflower	4	Parsley	1	Sweet Corn	2
Celery	3	Parsnip	1	Tomato	3
Cucumber	5	Peas	2	Turnip	4
Eggplant	5	Pepper	2	Watermelon	5

HOTBEDS

Hotbeds are extensively used by growers for the production of young plants for early vegetable crops. The production to maturity of vegetable crops, requiring a long growing season or for early markets is attained by the growing of young plants in the hotbed and coldframe during the weeks before outdoor planting is possible.

The successful operation of a hotbed demands much attention to ventilation, watering and temperature. Consequently close proximity to farm buildings, an ample water supply, and a greenhouse is desirable. The hotbed frame should face the south to secure as much sunshine as possible, be well sheltered from strong winds by artificial or natural windbreaks, and be located on well drained soil.

THE MANURE HEATED HOTBED

Fresh horse manure is the only type of manure which ferments sufficiently to provide the requisite heat. The most satisfactory manure is secured from grain-fed horses, utilizing two parts of manure to which has been added one part of straw. Shavings with manure is unsatisfactory.

About seven days previous to putting in the hotbed frames the fresh horse manure should be placed in a pile, four feet high and four to five feet wide. If dry at piling time the manure should be moistened to inaugurate fermentation. After two or three days the manure commences to steam, indicating the beginning of fermentation. At this time the manure should be forked over into another pile, arranging the outside of the first pile in the inside of the second pile. When fermentation again commences, usually two or three days, the manure is suitable for use in the hotbed. Should the manure fail to heat, open a hole in the manure and pour in boiling water.

On the site of the hotbed this fermenting manure is piled to a depth of eighteen inches to two feet and extending a foot from the sides and ends of the frame; and tightly tramped as each six inches of manure is added. If no flats are to be used in growing young vegetable plants, four to six inches of compost soil is placed on top of this manure. When flats are used two inches of soil are placed on the manure

and then the flats containing compost soil are placed on the two inches of soil. At this time the sash is set into position on the frame. Additional manure is piled around the entire frame, extending to the top, and aiding in retaining heat in the hotbed.

Subsequent to this preparation the hotbed should not be disturbed for four days except to slightly ventilate several hours a day, thereby allowing the escape of noxious gases from the manure.

When the soil is levelled and the temperature of the soil is between 80 and 90 degrees F. sowing or planting can commence, or the flats containing plants or seed can be inserted into the bed.

THE ELECTRIC HEATED HOTBED

This type of hotbed is now being used by growers. The heat is supplied by the resistance offered to an electric current as it passes through specially manufactured wire. This wire is lead covered. The lead-covered wire is placed on the well drained soil continuously in "rows," situated 8 inches apart, on a level with the bottom sides of the frame. The regular six inch depth of compost soil is placed on top of the wire. If flats are used they must be placed tightly together and three inches of soil must be situated on top of the wire underneath the flats filled with compost soil. Electric thermostats are used which automatically control the desired temperature of the air and soil in the beds.

To be thoroughly familiar with the latest methods of installation which may arise during the life of this bulletin, please refer to Canadian manufacturers and the Hydro-Electric Commission, Toronto.

COLDFRAMES

Coldframes are used to harden-off young plants ten days to two weeks before field planting. Their location should be in a sheltered place, convenient to the greenhouse or hotbeds and to the water supply. Good compost soil may be placed in the coldframes in which to grow the plants, but usually flats containing the plants are directly transferred from the hotbeds or greenhouse to the coldframes when no loose soil is required.

Many growers make a second use of the coldframes. After the plants are taken to the field the frames are partly filled with soil and decomposed manure or compost soil. Young cucumber or sometimes melon plants are planted into the soil and forced along for a time. Later the sash are all removed and the plants are allowed to grow without the protection of the glass. Early celery and lettuce are other crops which may be grown in the same manner.

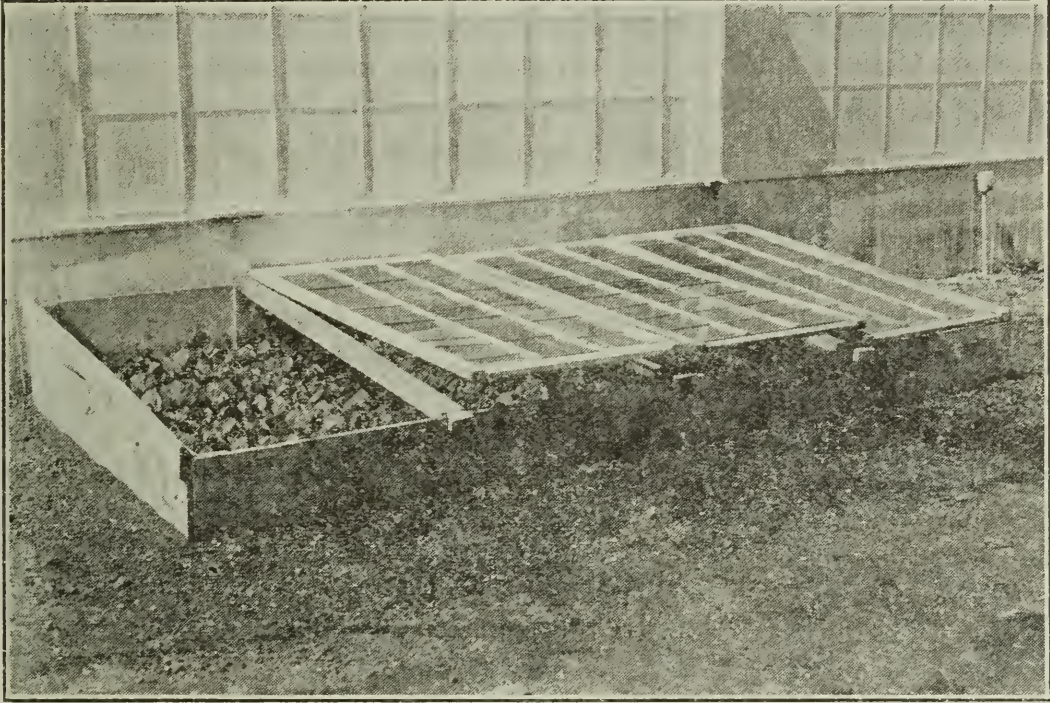
The ventilation and watering of the soil producing young plants in the coldframe or hotbed should aim to avoid sudden extreme changes in temperature and to maintain a moderately moist condition in the soil. Watering early in the morning or afternoon should be done to avoid damp foliage at night, as moist foliage provides a suitable condition for diseases.

FRAMES FOR HOTBEDS AND COLDFRAMES

These frames are composed of one inch lumber tightly fastened together.

The Single sash Frame has the sides and ends eighteen inches high at the high or back end and twelve inches high at the front or low end to afford the fall of the sash or one inch for every foot of length of the glass sash. This arrangement provides

a slope to permit the running off of rain from the glass sash, and to obtain the sunshine. The glass sash, three feet by six feet standard size, is situated tightly on the top of the frame. As many sash as desired, placed side by side, can be used to provide the desired length of frame. The sash bar is made from a 2 x 4-foot piece of wood of the length to firmly fit between the sides of the frame. The strip, nailed



Coldframe

to this piece of wood is $\frac{7}{8}$ inches wide and the same height as the depth of the sash, and is situated between the two adjoining sash.

The Double Sash Frame possesses sides 18 inches high and situated from 10 feet 10 inches to 10 feet 11 inches apart. Midway between the sides is a line of posts 6 feet apart placed into the soil. On top of these posts, 24 inches to 28 inches high, rests a ridge pole. Each glass sash, 3 feet wide by 6 feet long, is placed with end resting on the top of the side of the frame and the other end on the ridge pole. Thus the roof is composed of sash on each of the ridge pole, and provides sufficient slant for rain to run off. Sash bars are provided in the same manner as for the Single Frame structure. A so-called "Ridge Cap" consists of two boards which cover the junction of the sash at the ridge pole to direct the rain on to the sash and off the roof.

The Double Sash Frames permit the growing of taller plants than the single frames.

COMPOST SOIL

For growing the young seedlings and young plants for early outdoor vegetable crops the compost soil is prepared at least one year previous to seed sowing. This compost soil is made by placing in a pile alternate layers of sand loam sods and well-rotted farmyard manure. Each layer of manure is from one-third to one-half the depth of each layer of sods. If the sand loam is not possible to obtain, a very light clay loam sod is used as a necessary alternative. The sods of the top and sides and ends of the pile are placed upside down. Each layer of manure should be well tramped, and the manure and sods thoroughly soaked with water as each layer is placed in the pile.

At the time of using this compost soil for seed sowing or planting add sifted sharp sand from a lake shore or gravel pit—three-quarters of a bushel of compost soil to one-quarter bushel of the sharp sand. This sharp sand is of special importance when using the light clay loam sods compost.

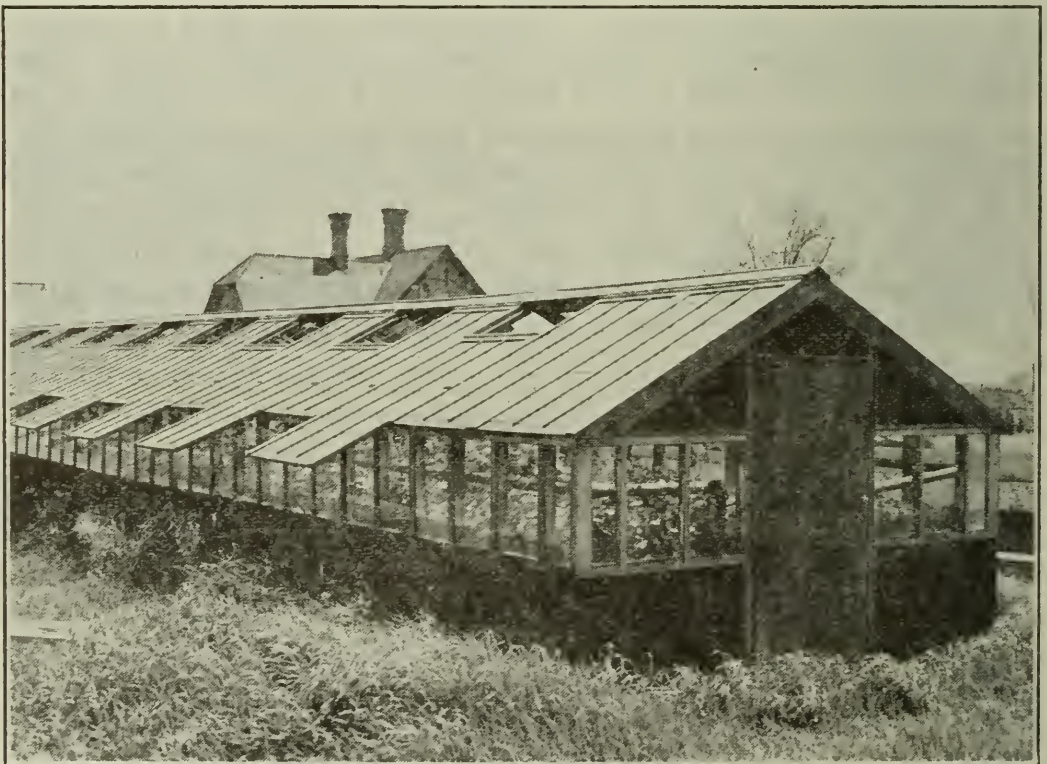
For growing the young seedlings and young plants for the various early outdoor crops this compost soil may be placed six inches deep on the manure of the manure or electric hotbed; in flats which are placed on two or three inches depth of any soil, on the manure of the manure hotbed; in greenhouse raised benches about $3\frac{1}{2}$ inches in depth of soil; or in various sized clay pots or berry boxes as per the individual crop demands.

THE EVEN SPAN SASH GREENHOUSE

Standard hotbed and coldframe sash—six feet long and three feet wide—form the roof of this building. At the ends of the building is glass.

The sidewalls are preferably made of poured concrete or concrete blocks; but are occasionally composed of wooden posts and lumber. The width from the outside of the sidewall to the outside of the opposite sidewall is 10 feet. The width of the concrete side and end walls should be at least 6 inches. With either the poured concrete or the concrete block side and end wall the two inch thick wood plate should be bolted to the top of the wall. When pouring the concrete or placing into position the top blocks, one-half inch diameter bolts 15 inches in length are placed upright every 6 feet. The bolts are placed through the bored holes in the wooden plate, and the plate firmly fastened down by placing nuts on the bolts.

One end of the six foot sash is placed on the top of the sidewall and the other end at the apex of the roof where the ends of the two sash meet. The length of the house used depends upon the space for plant production. Each rafter, in the form of a sash-bar already described in hotbed frames, extends from the top of the sidewall to the apex of the roof. Two rafters, each resting on opposite sidewalls, meet at the



A Sash Greenhouse

ridge pole or apex of the roof. The rafters are placed at 3-foot intervals along the top of the sidewalls. About one-fourth of an inch from the outer edge of each rafter and extending throughout its length, is a depression, called the "Drip-Gutter" to conduct rain water entering between the ends of the rafters, from the roof. The top ends of the sash fit tightly on the ridge pole. Covering the junction of the ends of the sash at the ridge pole is the "ridge cap", consisting of two boards, each $\frac{7}{8}$ inch thick by 6 inches wide, nailed tightly together and to the ridge pole to direct the rain on to the sash.

Every other sash is fastened in place by screws, while the other sash are used for ventilating purposes by sliding up and down the sides of the rafters.

Some growers would prefer to have about 3 to 4 feet in height of glass as a side-wall resting on the cement sidewall. The roof of 3 by 6 glass sash rests on these glass sidewalls. This arrangement permits more light inside the structure and more height for plants.

The raised bench is made of 1 inch to 1½ inch boards which are supported by upright and horizontal 2 by 4's. This bench is about 2 inches from the sidewalls to permit proper air circulation. The walk between the benches is 18 inches wide. The compost soil for growing the young plants is placed on the raised benches 6 to 8 inches in depth, while the top of this soil should be 10 to 12 inches below the glass sash at the eaves to permit the desired height of growth of plants.

The raised benches can be made to afford their easy removal from this greenhouse during the season when the young plants for the outside crops are not produced. With the absence of the benches the well drained dirt floor with proper fertility can be used to grow crops of greenhouse lettuce, radish and parsley and low growing flower crops. Sometimes this groundbed is used to produce greenhouse crops of tomato and cucumber. In such conditions these tall growing crops cannot be grown to their proper profitable commercial height; are not adequately ventilated on account of insufficient air between tops of plants and roof; and may suffer from frost damage due to close proximity to glass. The raised bench arrangement could be used to produce lettuce, parsley and radishes as greenhouse crops.

Hot water is the usual method of heating as it maintains a more even heat with less attention than does steam.

The 3-inch diameter "flow" pipe, situated immediately under the ridge pole, conveys the hot water from the boiler, situated at one end of the house, to the end of the house farthest from the boiler. Connected to the "flow" pipe at the end of the house farthest from the boiler are "return" pipes which carry the water back to the boiler, and which are six 2-inch diameter pipes with three pipes attached to each sidewall.

Only one high point should exist in the pipes. This high point should be provided with an air valve so that air in the pipes may be forced out in filling the pipes with water. If the high point is situated directly above the boiler there must be a gradual decline in the flow pipe and into the laterals, returning to the boiler. If the high point is at the end of the house farthest from the boiler the flow and return pipes must gradually decline from the high point. The expansion tank, containing at least five gallons of water, should be above the boiler and higher than the highest point in the pipes.

A quite satisfactory heating unit is comprised of a hot water heater attached to the above described pipe system. Some of these heaters are automatically regulated to minimize the attention of the operator. At the shaded end of this greenhouse a so-called "head house" of inch boards and 2 by 4 framework contains this heater and a coal supply.

The advantages offered by this structure in preference to the hotbed in growing young vegetable plants for the early outdoor crops comprise:

Transplanting and watering can be conducted with no danger of damaging the plants during any condition of weather;

Effective control of temperature and moisture in the atmosphere in the house, and ventilation;

More air space lessens opportunity of freezing.

SOIL STERILIZATION

Old greenhouse and old garden soils are usually full of damping-off fungi. It is necessary to sterilize these types of soil if one is to escape serious loss of the young seedlings and plants. One cannot be certain that these fungous diseases are not in the new soil. To be safe from these diseases which destroy the young plants, it is necessary to sterilize all soils if losses of these plants due to diseases are to be avoided. To sterilize this soil a dozen or more flats containing the soil are piled in a tight board box to permit steam under good pressure to pass entirely around the flats to maintain the temperature of the soil at 185 to 200 degrees F. for two hours. Nematodes are also controlled by steaming.

Where steam is not available, formalin may be used at the rate of one pint of formalin to ten gallons of water. Apply this solution at the rate of one gallon to one square foot of soil. Do not plant until ten days after treatment. The soil for either treatment should be dry. Formalin does not satisfactorily control nematodes.

IRRIGATION

Sufficient water for efficient amounts of moisture in the soil to assure continuous growth of vegetables, so requisite for high quality, is only definitely provided by some form of irrigation. Irrigation also controls the amount of moisture at such vital phases of vegetable production as immediately after seed sowing, or planting or growing in dry weather. More abundant vegetable crops are produced in Ontario with irrigation than without an assured supply of water.

Sub-irrigation arranges for the delivery of water to the roots from below. This system is used in some areas of muck and other lands by conveying the water in ditches from which it moves through the soil sideways and upward to the roots. In a few instances a tile drain system is used in conveying the water. Sub-irrigation is unsatisfactory with porous sub-soil or where a hard pan exists near the soil surface. An abundance of water is necessary.

Surface irrigation is only used where abundant amounts of water and a suitable slope of land prevails, very slightly in this Province.

Overhead Spray Irrigation—This system is the most commonly used in Ontario as water is supplied to the surface soil in the form of a spray or mist, much resembling a gentle rain. This method requires a small amount of labour to operate; provides for water economy, more uniform distribution of water; causes no washing of soil; and can be used on any type of land.

This system comprises pipe situated in parallel lines about fifty feet apart and supported on posts about six and one-half feet above the soil surface. Small nozzles at three-foot intervals in all pipes discharge a small stream of water which alights on the crops and soil in the form of a fine spray. Pressure forces the water through the pipes and nozzles, the pipes being automatically turned to provide the desired spray, uniformly over the entire irrigated area. Occasionally posts one and one-half to three feet high or wires attached to posts support the pipe lines.

Portable pipe lines equipped with nozzles are transported from one area of the crop to another. These pipes are laid on the soil surface between the rows of vegetables when irrigating, and attached to some pumping system which supplies pressure for forcing the water through the nozzles. The cost of installation of the portable system is less, and the cost of operation greater than with the Overhead Spray method. However, the Portable system does not use soil space as does the Overhead plan.

The cost of these systems and their details of installation can readily be secured from manufacturers of this irrigation equipment.

GREEN MANURING CROPS

From the atmosphere the plant secures carbon dioxide which is taken in through the leaves. From this carbon dioxide both carbon and some oxygen are secured. Oxygen is always being taken in by the leaves. From the soil water, absorbed by the roots, the plant secures hydrogen and oxygen. The small green bodies in the leaves, called chloroplasts, use the power of sunlight to manufacture sugars, starches and cellulose from carbon, hydrogen and oxygen. Carbon, hydrogen and oxygen make up about 90 per cent of the solid or dry material of the plant. The other part of the dry material in the plant consists of nitrogen, phosphorus, potash, lime, magnesium, sulphur, iron, boron, manganese, chlorine and others which are secured from the soil through the roots. These materials combine with sugars to form proteins and other substances in the plant. A continuous supply of all the essential elements of plant food is requisite because the absence or insufficiency of any one element prevents the complete development of the plant.

A soil is composed of mineral and organic matter. The organic matter comprises decaying plants. The plowing down of green manure crops and barnyard manure is a common method of replenishing and adding organic matter to our soils.

The beneficial physical effects of organic matter in the soil are of fundamental importance. Organic matter loosens up clay soils into a granular condition, facilitating cultural operations; while sandy soils are prevented from blowing and drying. Organic matter greatly increases the water-holding capacity of both soils, particularly near the soil surface where most of the vegetable crops reside. Thus the organic matter causes the soil to be in a satisfactory physical condition affording an extensively rooted plant capable of absorbing ample foods which produce vigorous plants. Also the growing green manuring crop, subsequent to a vegetable crop, utilizes soluble plant food remaining in the soil from a previously grown fertilized crop; and thus prevents severe leaching of these plant food elements.

Chemically, organic matter functions principally as a storehouse for nitrogen, one of the most necessary plant foods in the soil. The bacteria in the soil, to obtain food, break down the complex compounds in organic matter and eventually change them into available plant food. Notably nitrogen in the organic matter is changed by bacteria into nitrates which are nitrogen plant food for our vegetable crops. Too, the organic matter must be in the soil to afford the mineral matter in organic matter, soils and fertilizers to be transformed into soil for the growth of crops. Throughout the decomposition of organic matter all of the mineral elements residing in the organic matter are changed into plant foods. Also during the decay of the organic matter carbon dioxide is produced with water. This gas with water forms acid which renders the minerals in the soils and fertilizers into plant food for the vegetable crops.

Organic matter functions principally as a storehouse for nitrogen. Concerning the nitrogen supply from a green-manuring point of view we have two classes of

crops, namely legumes and non-legumes. Legumes as clovers and vetches possess nodules on their roots. In these nodules are bacteria which have the power of converting the nitrogen of the air in the soil into plant tissue. Non-legumes, as rye and oats, do not possess these nodules. Consequently when we plow down a legume we place back into the soil all of the mineral elements taken from the soil to produce the legume and in addition free nitrogen taken from the atmosphere. Thus the legume has afforded an increase in nitrogen to the soil. The plowing down of a non-legume puts back into the soil all of the mineral elements taken from the soil in the growth of the non-legume but no additional nitrogen. The plowing down of a legume or non-legume crop adds organic matter to the soil.

CROPS—With crops such as onions, parsnips and tomatoes occupying the soil for almost the entire growing season, and when producing two crops of vegetables in succession on the same land during one growing season, winter rye is practically the only suitable crop. At the conclusion of harvesting the full season crop or the last crop in the one year succession this rye is sown at the rate of 3 bushels per acre. Winter rye sown September 1st to 15th, will produce about six inches of growth before the usual freeze-up in November; and can be plowed down as early as the first week in April in many sections of the country when about 8 inches in height. When sown in October, 1st to 15th, a suitable growth is obtained by the middle of the following May.

1. The Sweet Clover is sown at the rate of 30 pounds per acre about July 20th, and is plowed down during the following May when about 12 inches high.

2. Hairy Vetch winters over and is plowed down in the early spring. Whether sown alone or with Winter Rye, Hairy Vetch should be seeded during the latter part of July and not later than the first week in August. Vetch is sown alone at the rate of 60 to 80 pounds per acre, and when sown with Winter Rye, Vetch at 20 pounds per acre and Winter Rye at 1½ bushels per acre.

Growing and plowing down green manuring crops subsequent to vegetable crops as already mentioned, prevents leaching of soluble plant foods in the soil which have not been used by the immediately preceding vegetable crop. The green manuring crops as Hairy Vetch, Winter Rye and Sweet Clover prevent erosion of land in the fall, winter and spring months, and afford earlier cultivation and planting than does bare land because the leaves give off a great deal of water secured from the soil.

3. Previous to the vegetable crops of late cabbage, late celery, late potatoes, green manuring crops, sown as early as possible in the spring, can be plowed down when no green manuring crop has occupied the land during the winter months. However, this plan is not as satisfactory as having the green manuring crop immediately follow the vegetable crop in the autumn because, as just mentioned, the leaching of plant foods in the winter months would be detrimental to succeeding vegetable crops. For this particular plan of cropping a combination of oats at two bushels per acre and peas at one bushel per acre is suitable.

All green manuring crops should be plowed down when in a succulent growing state, particularly when spring plowed. The plowed down green manure, unless thoroughly incorporated into the soil at plowing down time will provide a very detrimental layer of organic matter in the soil which will prevent the rise of capillary water from the lower soil layers to the roots of the vegetable crops in the surface soil. To overcome this detrimental condition plowing should be conducted so that furrow slice is on edge to promote the mixing together of soil and organic matter. Immediately after plowing down the soil should be packed with a heavy roller or culti-packer and then thoroughly disked. Oftentimes beneficial results are secured by

thorough disking prior to plowing to cut the green manuring crop before incorporation into the soil and thus secure more rapid decay.

BARNYARD MANURES

The importance of manure in market gardening can scarcely be over estimated. Its value is in part, attributed to its fertilizer qualities but perhaps as much to the fact that it is an ideal source of organic matter to maintain the large supply of humus in the soil which is so essential to crop growth.

When manure is obtainable at relatively low cost per ton, heavy annual applications as high as 40 tons or more per acre, are often made. With the increasing use of fertilizers at lower prices and the growing scarcity of manure with attendant increased cost per ton, vegetable growers are much concerned as to what extent green manure crops and fertilizers can replace farmyard manure. Experiments at the Rhode Island Experimental Station have shown that commercial fertilizers in a green manure rotation can be substituted to a great extent for manure with a consequent larger net financial return per acre.

It is impossible to place a money value on the total effect of manure applied as there are so many variables entering into the question. As a source of humus, the effect will be much greater on soils deficient in organic matter than on soils well supplied with organic matter.

The various beneficial effects which manure exerts on the soil may be classified as physical, chemical and biological

The physical effects of manure on heavy soils are that it renders it more porous and friable, assisting drainage, aeration, ease of cultivation and, in general, creating a very favourable medium for plant growth. On light sandy soils the organic colloids in the manure tend to bind the particles of sand together, making the soil more compact, thereby increasing water-holding capacity and preventing the leaching of plant nutrients. Large amounts of organic matter tend to impart a dark colour to the soil which increases its heat absorbing capacity.

The fertilizer value of farmyard manure is chiefly due to the amounts of nitrogen, phosphoric acid and potash added to the soil and then liberated by the subsequent decomposition of the manure in forms easily assimilated by the plant. During the process of decay the organic materials produce many acid compounds which increase the availability of the mineral plant nutrients in the soil.

Organic matter is the home of soil micro-organisms which are actively engaged in the breaking down and building up of organic and inorganic plant nutrients in forms which the plant can assimilate them. Farmyard manure acts as an excellent medium for their development, supplying both food and favourable environments. Light applications of manure on newly broken peat or muck lands usually give marked increase in plant growth by acting as a source of quickly available energy for beneficial bacteria that hasten decomposition of the organic matter with consequent release of plant nutrients.

CHARACTERISTICS AND COMPOSITION OF MANURE

The composition of manure is very variable, depending upon the class, age and function of animal producing it, source of feed, amount of care used in its conservation, amount and sources of litter for bedding, and degree of decomposition.

The following table prepared by Dr. F. T. Shutt, Experimental Farm, Ottawa, presents the approximate average composition of fresh, solid and liquid portion of manure produced by farm animals in percentages and pounds per ton:

APPROXIMATE AVERAGE COMPOSITION OF FRESH MANURE FROM
VARIOUS ANIMALS (after Shutt)

Kind of Animal	Relative proportion of solid excrement, liquid excrement and bedding in manure	Lbs. per Ton	Nitrogen		Phosphoric Acid		Potash	
			P.C.	Lbs.	P.C.	Lbs.	P.C.	Lbs.
Horse	Solid Excreta	1200	1.53	6.60	0.36	3.60	0.40	4.80
	Liquid "	300	1.35	4.05	T r a c e		1.25	3.75
	Bedding material	500	0.50	2.50	0.15	0.75	0.60	3.00
	Total mixture	2000	0.66	13.15	0.22	4.35	0.58	11.55
Cow	Solid Excreta	1260	0.40	5.04	0.20	2.52	0.10	1.26
	Liquid "	540	1.00	5.40	T r a c e		1.35	7.29
	Bedding material	200	0.50	1.00	0.15	0.30	0.60	1.20
	Total mixture	2000	0.57	11.44	0.14	2.82	0.49	9.75
Pig	Solid Excreta	990	0.55	5.44	0.50	4.95	0.40	3.96
	Liquid "	660	0.60	3.96	0.10	0.66	0.45	2.97
	Bedding material	350	0.50	1.75	0.15	0.42	0.60	2.10
	Total mixture	2000	0.56	11.75	0.30	6.03	0.45	9.03
Sheep	Solid Excreta	1206	0.75	9.04	0.50	6.03	0.45	5.43
	Liquid "	594	1.35	8.02	0.05	0.30	2.10	12.47
	Bedding material	200	0.50	1.00	0.15	0.30	0.60	1.20
	Total mixture	2000	0.90	18.06	0.33	6.63	0.95	19.10
Poultry	Solid Excreta	1900	1.00	19.00	0.80	15.20	0.40	7.60
	Bedding material	100	0.50	0.50	0.15	0.15	0.60	0.60
	Total mixture	2000	0.97	19.50	0.77	15.35	0.41	8.20

From a study of the table the following points are outstanding: (1) That manure contains more nitrogen and potash than phosphoric acid, hence is an unbalanced form of fertilizer; (2) That the liquid manure is exceptionally rich in nitrogen and potash; (3) That valuing nitrogen at 12 cents per pound, phosphoric acid at 7 cents and potash at 5 cents per pound, the monetary value of fertilizing constituents in manure per ton, from each class of animal is in the following order: Poultry, Sheep, Pig, Horse and Cow.

APPLICATION OF MANURE

Many growers prefer to apply the manure on the land during the winter or early spring in order to save time and labour. Providing the manure is not too strawy or the land too heavy or rolling this is a good practice. However, large quantities of fresh strawy manure turned under, will result in a depletion of available nitrates in the soil, prove harmful to the young growing crop and necessitate applications of some form of readily available nitroten, especially if quick growth is desired. The effect on heavy soils would be to retain excessive moisture in the soil keeping it cold and wet and retarding early growth. On very rolling land there is danger of much loss of plantfood by erosion during the early spring rains.

FRESH VS. WELL ROTTED MANURE

The majority of vegetable crops are grown on light, sandy loams. Moreover, the grower desires to obtain relatively immediate results from the manure applied. To procure this it is desirable to apply well rotted instead of fresh, strawy manure. In the process of rotting manure, fermentation decomposes the more resisting forms of litter, rendering the plant food more readily available to the growing plant. However, during the process of decay there is a large loss of organic matter which is of important value on soils low in humus.

A ton of well rotted manure contains more plantfood than fresh manure, as shown in the following table prepared by Dr. F. T. Shutt of Ottawa:

Pounds Per Ton			
	Nitrogen	Phosphoric Acid	Potash
Fresh manure	7.5	3.6	9.0
Rotted "	10.3	8.5	15.9

On heavier soils or when applied to slow growing plants, fresh strawy manure may be of greater value than well rotted manure.

STORAGE OF MANURE

Many growers purchase large quantities of manure at considerable expense and store it in heaps for several months. Care should be exercised in building the pile so that excessive leaching and drainage are prevented. Also it is very important to keep the pile as compact and moist as possible to prevent losses of nitrogen, potash and organic matter through over-heating and resulting in a fire-fanged condition.

If the above method of purchase is an annual practice, the grower would be well repaid to construct a concrete container of suitable size to conserve these valuable soluble nutrients. If there is excessive heating, some convenient form of watering should be arranged for.

LOSS OF FERTILIZING CONSTITUENTS IN THE ROTTING OF MANURE

The following table illustrates the possible losses of nutrients in the storage of manure as determined by Dr. F. T. Shutt, Ottawa:

	At beginning of experi- ment Fresh Manure	At the end of 3 months		At the end of 6 months		At the end of 9 months		At the end of 12 months	
		Protec- ted	Exposed	Protec- ted	Exposed	Protec- ted	Exposed	Protec- ted	Exposed
Wt. of Manure	8000 lbs.	2980 lbs.	3903 lbs.	2308 lbs.	4124 lbs.	2224 lbs.	4189 lbs.	2185 lbs.	3838 lbs.
Organic Matter	1938								
Loss in lbs.		1058	1147	1135	1286	1178	1290	1168	1331
% loss		55	60	58	65	60	67	60	69
Nitrogen	48								
Loss in lbs.		8	14	9	15	11	19	11	19
% loss		17	29	19	30	23	40	23	40
Phosphoric acid	25								
Loss in lbs.		None	2	None	3	None	4	1	4
% loss		None	8	None	12	None	16	4	16
Potash	62								
Loss in lbs.		None	14	2	18	2	21	2	22
% loss		None	22	3	29	3	34	3	35

ARTIFICIAL MANURES

In consequence of the universally recognized necessity for livestock manure and its decreasing supply with attendant higher prices, attention is turned towards the possibility of supplementing the supply of stock manure with manure manufactured from straw, corn stalks and other waste residues. Experiments have proved that well-decomposed, artificial manure of this type compares very favourably with farm manure on crop growth, crop yield and soil conditions in general.

During the war a process for manufacturing manure from waste was developed and patented at the Rothamsted Experimental Station, England, and the necessary chemicals sold under the name of "Adco". Recent investigations in this country show that very satisfactory decomposition can be brought about in three months, providing the main factors are present, namely: moisture, a source of soluble nitrogen and phosphorous, and neutral or alkaline conditions.

The investigations indicated, however, that owing to the labour involved, the large amounts of water necessary, and the cost, the method is only practical where intensive farming is practised. A satisfactory mixture of chemicals consists of 45 pounds ammonium sulphate, 40 pounds of finely ground limestone, and 15 pounds super-phosphate, applied at the rate of 150 pounds per ton, of straw or refuse. The method of procedure is to make a compact layer of straw or refuse about 6 inches deep, wet thoroughly with water, and spread the reagent on it at the rate of 150 pounds per ton. Repeat this operation layer by layer, until a height of 6 to 8 feet is obtained. Successive layers may be added as waste material accumulates. It is important that the pile be kept as flat as possible. Fermentation soon starts and the temperature rises. Frequent watering is necessary to control the temperature, replace losses by evaporation and drainage and maintain bacterial activity; a moisture content of about 75% is required to be maintained. While the decomposition is proceeding, it is necessary to fork over the mass two or three times at intervals during the period of decomposition. After some three months, depending upon conditions, a decomposed mass of material resembling well-rotted farmyard manure, is obtained. It is claimed that one ton of straw or refuse will make from two to three tons of rotted manure.

Summarizing, the essentials are as follows:

1. Proper care in building the pile;
2. Proper treatment with chemicals;
3. Adequate watering;
4. Subsequent watering and forking over to keep down the temperature and facilitate decomposition.

By depending upon the normal rainfall, the same results may be obtained, but a much longer period of time will be required.

The cost per ton of dry material may be estimated as follows:

68 lbs. ammonium sulphate at \$45.00 per ton.....	\$1.53
22 " superphosphate at \$20.00 per ton.....	0.22
60 " limestone at \$5.00 per ton.....	\$1.15

Total..... \$1.90

It is estimated that approximately 800 gallons of water is required per ton of straw; to this must be added the value of straw and labour, which will vary with localities.

FERTILIZERS

The market gardener must have a very thorough knowledge of the principles and use of commercial fertilizers. He grows a wide variety of high cost per acre crops that are very sensitive to conditions of soil and source and amount of plant nutrients. Furthermore, slightly unfavourable conditions which may be in the soil, in the source, amount, time or method of application of fertilizer will upset the delicate balance required for maximum growth. Another important point is that science has greatly multiplied the number of sources of plant food nutrients offered for sale, each with specific characteristics and varying prices per unit in plant food. Often the investment for fertilizers may be materially reduced by buying a cheaper source of plant nutrients that may be as well or better adapted to the soil and crop requirements.

The primary function of a commercial fertilizer is to supply plant nutrients, but the addition is usually made to supplement the soil constituents rather than constitute a major source. The crop, even though fertilized, continues to depend on the soil for a large proportion of its mineral substance. Besides supplementing the nutrients already present in the soil, another function is expected of the fertilizer added. It should establish a proper proportion between the essential elements of nutrition which is important in order that an under or over-stimulation of the crop does not occur, and abnormal developments are not encouraged. Ideally, the fertilizer added should supplement the soil nutrients so as to provide for the plant the correct proportion of nitrogen, phosphoric acid and potash to produce a large and normal growth. In practice this is very difficult because the soil is more or less an unknown quantity as to the probable availability of its constituents. Moreover, it is difficult to forecast reactions that may occur in the soil, to what extent the fertilizer may remain active and available in the soil and what the seasonal conditions may be, which will affect the whole relationship between the soil, fertilizer used and crop response.. Nevertheless, the ideal should always be the objective. Much depends, therefore, in fertilizer practice, on the good judgment of the grower, his ability to anticipate conditions influencing the amount of kinds and methods of applying fertilizer, his own experience of the past, his neighbors, and always keeping in mind results obtained from the many experimental stations.

Of the ten elements known to be essential for plant growth only three, namely, nitrogen, phosphoric acid and potash are usually necessary to be added in the form of commercial fertilizers. Calcium in the form of calcium carbonate (Agricultural Limestone) is necessary if the soils are acid. It acts partly as a plant nutrient, but more particularly as a source of basic material in order to counteract toxic conditions present within the soil. Soil Science is finding that very small amounts of other elements such as magnesium, manganese, sulphur and boron prove exceptionally beneficial under certain conditions for some crops and many fertilizer companies are attempting to take care of these conditions by including them within the fertilizers offered for sale.

To use fertilizers intelligently and judiciously, it is necessary not only to understand the characteristic requirements of the soil, but it is essential to have a thorough knowledge of the function of the three fertilizer constituents, nitrogen, phosphoric acid and potash, and understand the characteristics of the many different sources of these constituents in order to be in a position to select and apply the most economical form to the crop grown.

NITROGENOUS FERTILIZERS

Of the three elements usually applied in commercial fertilizer, nitrogen seems to have the quickest and most pronounced effect on plant growth. Its primary function is to promote above the ground vegetative growth and it imparts to the plant a deep green colour. It also tends to give succulence, a quality particularly desirable in many vegetable crops. Soils that are abundantly supplied with nitrogen are usually dark in colour, as there is a direct relationship between the amount of organic matter in the soil and their total nitrogen content. If the soil is sandy or grayish in colour, strongly acid, low in available phosphoric acid, subject to long periods of flooding, or extremely dry, and if there has recently been heavy applications of strawy manure or organic materials having a wide carbon-nitrogen ratio, the soil is probably low in available nitrogen.

Of the three constituents nitrogen is the only one when added in excess that will give pronounced harmful effect on the growing crop, which may be exhibited by the following conditions: (1) Delaying of maturity by encouraging excessive vegetative growth and danger of loss by early frosts or winter killing; (2) Weakening of the straw or stems of tall plants, causing lodging; (3) Lowering of the quality of fruits or seeds by promoting the development of a watery condition; (4) Decreasing resistance to disease, probably due to a change in physiological condition within the plant, causing a thinning of the cell walls and allowing the more ready entrance of disease germs. However, in the case of spinach, lettuce and grasses, heavy applications of nitrogen are not considered harmful and may be used quite freely with safety, the cost of material being the only limiting factor.

Deficiencies of nitrogen in the plant may be indicated by the following signs: (1) Plants grow slowly and leaves are pale green in colour; (2) The leaves of plants are shed prematurely, the growth is stunted and bears little fruit; (3) Plants tend to "fire", that is, leaves die from midrib outward to edge; (4) Plants tend to produce fruit prematurely.

The effect of nitrogen fertilizers on growth are more subject to seasonal conditions than any of the other plant nutrients. Consequently the grower should acquaint himself with the conditions under which nitrogen fertilizers are especially effective. If any of the following seasonal conditions prevail, very cool and wet, very dry, or abundance of sunshine, application of nitrogen fertilizers will be very effective. It is generally accepted that there is no residual effect of readily available forms of nitrogenous fertilizers the second year.

Nitrogen fertilizers may be divided into two classes, inorganic and organic forms.

Sodium Nitrate secured from Chile, often referred to as Chilean Nitrate of Soda, is a form of natural inorganic nitrogen which is readily soluble in water and can be immediately absorbed by the growing plants. It contains 15.5 percent of nitrogen, is shipped in waterproof bags, and is a fine granular or pellet form, making it very easy to apply. There is also a synthetic form of sodium nitrate containing the same amount of nitrogen in the same form. Recent experiments have shown that one form is as effective as the other in promoting growth. Applications of 250 pounds per acre may be used with safety, but heavier amounts should be applied in two or more applications in order to prevent loss of nitrate nitrogen by leaching, especially in open porous soils.

Ammonium Sulphate is a greyish-white crystalline salt, usually containing 21 percent nitrogen. It is chiefly made synthetically from the atmospheric nitrogen but also obtained as a by-product from the manufacture of coke. At present it is one

of the cheapest sources of nitrogen on the market and is used extensively in mixed fertilizers and applications for top or side dressings. Under normal conditions it is available to all plants within a few days. For many plants, it acts as an immediate source of nitrogen as they have the ability to utilize either ammonia or nitrate nitrogen. Providing care is taken, heavy applications, up to 250 or 350 pounds per acre, may be made without great danger or loss by leaching, except on very light sandy soils. Long continued use of ammonium sulphate will increase soil acidity, but this effect may be counteracted by periodical applications of ground limestone. Its efficiency is somewhat decreased on very acid soils where possibly a basic source of nitrogen, such as nitrate of soda, cyanamid or nitro-chalk would be more satisfactory.

Calcium Cyanamid contains 22 percent nitrogen and calcium equivalent to 70 per cent lime in the hydrated form. It is black in colour and may be secured in two forms, powder or small pellets. The latter is a recent form of manufacture and the improved physical condition greatly aids application. Until recently Calcium Cyanamid has been used altogether as a part source of nitrogen in mixed fertilizers, but is now sold retail for use as a top or side dressing. Experiments have shown it to be a very desirable form of nitrogen but care must be exercised in application otherwise injury will result from burning and germination will be decreased. The nitrogen is slowly available throughout the growing season and applications up to 250 pounds per acre may be made with safety provided it is applied a few days before seeding. Experiments have shown that continued use of cyanamid on acid soils reduces the acidity.

Urea is a water-soluble source of organic nitrogen and readily becomes available to the plant. It occurs in the small pellet form and is the most concentrated of all forms of nitrogen fertilizer containing 46 per cent. Owing to its concentration, it must be used with care, but may be used continuously without detrimental results to the soil.

Dried Blood Meal is a natural organic source of nitrogen obtained from abattoirs. It contains 12 percent nitrogen, which is rather slowly available in cool, wet soils, but relatively quickly available in light, warm soils. It may be used with safety in large amounts on all crops and there is no immediate loss of nitrogen by leaching.

Tankage is also a natural source of organic nitrogen obtained as a by-product from the abattoirs and containing from 5 to 10 percent nitrogen, and 8 to 12 percent of phosphoric acid. The nitrogen is slowly available and will last over the growing season. It may be applied in relatively large amounts per acre, without danger of loss through leaching or injury to the growing plant. The phosphoric acid content also adds to its value. It is a relatively economical source of nitrogen and phosphorus especially for slow growing plants. Its rate of availability is medium.

There are many other sources of nitrogen in combination with phosphorus and potash, such as ammophos and nitrophoska, which will be discussed under the section dealing with concentrated fertilizers.

PHOSPHATE FERTILIZERS

Many of our soils are deficient in phosphoric acid and, since manure is low in this constituent, the addition of phosphoric acid is usually attended with increased production and betterment of growth. It is difficult to state the exact functions of phosphorus in the plant but cell division, formation of proteins, fats, starch and

sugars cannot proceed without it. The close connection between phosphorus and cell division may account for the large amount of phosphorus compounds stored up in the seed, and also the relatively large amounts of phosphorus taken from the soil during the early stages of plant growth. In general heavy soils and mucks are usually deficient in easily soluble phosphates and respond to heavy applications. Light, sandy loams also respond to phosphatic fertilizers, but continued applications of this material alone would soon bring about a condition where nitrogen and potassium become limiting factors.

Phosphoric acid deficiency in soils is usually present if the soils are heavy, fairly well to well drained, medium to low in organic matter, strongly acid and if there is a deficiency or excess of available nitrogen.

The outstanding external effect of phosphoric acid on the plant is (1) Hastening maturity, which is of special value in wet seasons, cold climates and short seasons and (2) Root development, especially the lateral and fibrous rootlets, which are greatly increased by applications of phosphoric acid, thus reducing winter injury to fall sown crops and aiding those of restricted growth in search for water and plant nutrients; also providing a readily available supply for their rapid development in the early spring; (3) For cereals or tall growing plants phosphates will tend to stiffen the stems and produce plumper seeds; (4) Also, it is well known that the food value of crops is greatly improved and that plants are more resistant to disease which is probably brought about by a more normal cell development, thus counteracting the influence of excessive nitrogen.

The following conditions appearing in plants are indicative of phosphorus deficiency:—stunted growth, slow rate of maturity and small yield of seeds in proportion to straw. Young tomato plants deficient in phosphorus have a stunted, constricted, ridged appearance with very few hairs on the stem.

The climatic factors that increase the efficiency or the demand for phosphoric acid are a cool, moist season that favour rank vegetative growth or, if the early spring is moist but followed by drought, later in the season.

Phosphoric acid does not leach from the soil except in very minute quantities, hence continued heavy annual applications of phosphatic fertilizers tend towards an accumulation of phosphates in the soil with possible detrimental results, especially on soils where nitrogen and potash are limiting factors. In extensive agriculture, phosphoric acid should be the predominating constituent in fertilizers. In intensive farming, where heavy annual applications of fertilizers are made, which is usually on light soils and mucks, nitrogen and potash are often of equal or greater importance than phosphoric acid.

There are many forms of phosphatic fertilizers on the market, each having their valuable characteristics according to soil conditions and kind of crop grown. However, considering the cost of producing market garden crops and their value per acre, the cost of the fertilizer used is only a relatively small percentage of the total investment, hence it is very desirable to use forms that are immediately available to the plant.

Superphosphate (Acid Phosphate) is a greyish material, sold either in the powder or granular form and contains 16 or 20 percent phosphoric acid (P_2O_5), which is in a form immediately available to the growing plant. It is practically the only source of phosphoric acid in mixed fertilizers. It may, by suitable methods of application, be applied alone at rates up to 2,000 pounds per acre, without injurious effects. Superphosphate is more efficient when applied on soils well supplied with

lime. When applied on acid soils, it will help to overcome the toxic conditions usually present in lime deficient soils.

Treble Superphosphate is a grayish material sold in the granular form. It contains 45 percent phosphoric acid, which is approximately three times as concentrated as superphosphate. It may be used quite safely instead of superphosphate providing the same number of pounds of plant food are applied. The phosphorus is in the water soluble form and readily available to the growing plant.

Steamed Bone Meal contains 1 to 2 percent. nitrogen and 22 to 25 percent phosphoric acid. It is a relatively expensive form of phosphoric acid, which is rather slowly available in the soil. However, large quantities may be applied to the soil with safety and used continuously without injurious effects. When used it should be applied to slow growing plants or those that have a strong feeding power for phosphorus.

Rock Phosphate contains about 30 to 35 percent phosphoric acid in a difficultly soluble form. It is a very cheap form of phosphoric acid, about half the price per pound of plant food as compared with superphosphate. This form of phosphate is very slowly available and for vegetable crops is not generally recommended, except as a means of building up the phosphate stock in soils at a low cost. Rock phosphate is most effective when applied on muck soils or mineral soils high in organic matter and quite acid in reaction, and sown to crops that have a strong feeding power for phosphorus. There are other forms of phosphatic fertilizers on the market but these are not generally used by vegetable growers.

POTASSIUM FERTILIZERS

All mineral soils contain relatively large amounts of potassium, especially those of high colloidal content.

Muck soils contain very small amounts and as a rule fertilizers high in potassium should be used on this type of soil. Sandy soils contain considerably less potassium than clay soils and in a much less available form. Therefore, considering that the majority of vegetable crops are grown on light, sandy and muck soils, potassium forms a very important constituent of the fertilizer. Potassium does leach from the soil but not in excessive amounts, therefore marked residual effects are often noted.

Potassium produces distinct effects on plant growth, namely:

(1) Improved health and vigour of the plant, thereby increasing resistance to disease, and increases the efficiency of the leaves for synthesising and translocation of carbohydrates;

(2) It plays an important part in the growth of legumes and formation of seeds and fruit;

(3) Potassium tends to decrease the rate of maturity thus counteracting the effects of excessive phosphoric acid. Similar to phosphoric acid, excess potassium in the soil is not considered harmful.

(4) In general it exerts a balancing effect on both nitrogen and phosphorus and should be seriously considered when selecting the fertilizer mixture for the crop.

Plants deficient in potassium may be indicated as follows:

(1) Susceptibility to disease;

(2) If leaves die prematurely from edges toward midrib;

(3) Stunted appearance and failure to reach maturity;

(4) Shrunken seeds;

(5) Leaves become dull in colour and blotchy. Tomato and potato plants having very dark, unhealthy green, thick, heavily wrinkled leaves with edges turned down and brownish in colour, indicates potassium starvation.

The seasonal conditions in which potassium is very effective are cool and cloudy weather, warm with plenty of rain and high humidity, periods of hot, dry weather following rain.

The two principal sources of potash used are potassium sulphate and potassium chloride, which are imported from Germany and France, and used extensively as a source of potash in mixed fertilizers. Occasionally the carbonate or nitrate forms of potash are used.

Potassium Sulphate (Sulphate of Potash) occurs in the powder form, colour variable but usually light brown and containing from 48 to 60 percent potash (K_2O) in a water soluble form. It may be applied quite safely in applications up to 1,000 or more pounds per acre.

Potassium Chloride (Muriate of Potash) occurs in granular form of variable colour, ranging from grayish white to grayish black and contains from 48 to 60 percent potash (K_2O) in water soluble form. It may be used similarly to potassium sulphate.

In general, muriate of potash is used more extensively than the sulphate form. However, there are certain crops which seem to be injuriously affected in yield and quality by the use of chloride of potash. These crops are tobacco, potatoes and sugar beets, with tobacco showing the greatest evidence of injury. Marked improvements in yield and quality of these crops have been obtained when the source of potash was derived wholly or in part from sulphate of potash.

Potassium Carbonate occurs in a white floury form, containing about 50 percent potash (K_2O) in a water soluble form. It is not used very extensively.

Wood Ashes is an excellent and one of the oldest sources of potash and at one time valued very highly and carefully saved. Unleached, hardwood ashes contain from 10 to 12 percent potash in the carbonate form and about 40 to 45 percent lime. If subject to leaching, approximately half of the potash is lost. Coal ashes have practically no manurial value but act mechanically on the soil.

There are many more sources of potash such as sulphate of potash-magnesia, Kainit, Kemfert, Hard Salt and Kelp, which are not used very extensively but are discussed in Ontario Department of Agriculture Bulletin No. 364.

APPLICATION OF FERTILIZERS

METHODS: A little fertilizer well placed is worth double the quantity improperly applied. The time, method and rate of application of fertilizer will be determined by the nature of the materials, soil type, climatic conditions, kind of crop with method of growing, and economic returns. Much investigational work recently done has shown that the closer the fertilizer can be placed to the roots or seeds without causing injury, the more effective will be the results. With the exception of closely planted crops, row application of the materials is the most desirable and nearly all of our up-to-date machinery is equipped with devices to apply the fertilizer in bands approximately $2\frac{1}{2}$ inches to each side of the root or seed and on the same level in the case of deep planted crops like potatoes, or 3 to 4 inches below the surface for shallow

planted crops. On closely planted crops where row application is impractical, broadcast applications disked in previous to planting, are recommended.

RATES: The amount of fertilizer used will depend upon the money return of the crop, amount of manure applied and method of application. High money return crops will usually warrant a reasonably heavy expenditure for fertilizer because soil fertility should not be a limiting factor.

Manure is rich in nitrogen and potash, but low in phosphoric acid. Heavy applications will usually warrant a proportionately smaller application of fertilizer which should be somewhat higher in phosphorus to balance the manure.

Heavier applications of fertilizer are recommended when applied broadcast, owing to the possibilities of leaching or fixation of plant food before the roots are able to reach it. To obtain the greatest returns from the investment in fertilizers, soil fertility should be the only limiting factor. The necessity of putting the soil in the best possible condition for plant growth is paramount, which means that adequate drainage, lime, organic matter, tillage and the best source of seed or plants planted at the right time is essential.

The fertilizers recommended in this bulletin should not be taken as absolute. They are the results of long time experimental work under certain conditions and will fit the majority of requirements. Soils differ from field to field, not only in type but even on the same type due to cropping and manurial practices. Therefore, it may be very desirable to use an entirely different mixture than recommended, especially if the soil has been tested and the change in fertilizer based on definite information.

HIGH ANALYSIS

With the past few years several forms of high analysis or double strength mixed ingredient fertilizers have been placed on the market. Where large quantities are purchased and applied at heavy rates, they can often be purchased and applied at a considerable saving of labour and money. Experimental work has proved that they are as satisfactory as the ordinary forms provided care being exercised in methods of application and used on the basis of equal amounts of plant food units per acre.

The advantages of using high analyses or double strength fertilizers are (1) that the actual cost per unit of plant food is much less; (2) they are usually in an excellent mechanical condition; (3) less labour in handling of material is involved.

RESIDUAL EFFECTS OF FERTILIZERS

The economics of vegetable growing usually require rather heavy annual applications of fertilizers. Such practice, when continued over a long period of years, will have a pronounced effect on the balance of soil fertility. Certain constituents are absorbed by the soil and tend to accumulate. Others are leached away; the amounts of each varying according to the soil type and plant food requirements of the crops grown.

The nitrogen not used by the plant will largely leach to the lower levels. Phosphorus is readily absorbed by the soil and will accumulate. Potassium salts do not leach to any great extent except in open textured soils. Also the soil reaction may be greatly changed, according to the source of fertilizer ingredients used.

The use of one particular fertilizer mixture may at first give good results but owing to the accumulation of constituents or effect on soil reaction, it may later be necessary to use an entirely different ratio if continued successful growth of good quality crops is desired.

Aside from close observations on the character of growth to note these possible changes, it is desirable that the grower take advantage of the soil advisory service offered by the Department of Chemistry, Ontario Agricultural College, and have the soils periodically tested to determine the relative amounts of available constituents present and so accordingly adjust his soil fertility program to maintain the desired balance of fertility.

MINOR ELEMENTS

Owing to the wide-spread soil requirements for nitrogen, phosphorus and potash, the great majority of soil and plant studies have been confined to these three so-called primary plant nutrients. Within recent years, soil and plant research workers have noted that under some conditions other minor or rare elements present in very small amounts have a very important function in plant nutrition. Among the most important of these are boron, copper, iron, iodine, magnesium, manganese and sulphur.

While it is known that all these elements are not deficient in Ontario soils, recent experimental evidence has shown that crops grown on certain soils, particularly the mucks, have responded to applications of copper sulphate and sulphur. Other soils have indicated by plant symptoms that there is a deficiency of boron.

However, there is yet insufficient experimental evidence to give definite recommendations. Therefore, it is well for the grower to carefully note unusual plant growth symptoms when adequate amounts of nitrogen, phosphorus and potash have been supplied and consult the experimental station to determine the cause.

HOME MIXING

Some vegetable growers desire to mix their own fertilizers. This can be done quite satisfactorily providing certain precautions are taken. One of the chief advantages in home mixing is that the grower can make any formula which he thinks suits his particular conditions. For small amounts, it certainly does not pay to go to the trouble, but if many tons are used by a grower or group of growers, it may be profitable. The disadvantages of home mixing are amount of time and labour involved with the possible use of incompatible materials and consequent result of poor physical condition, less of available plant food, also an uneven mixture. By taking advantage of cash discounts and co-operative buying by the carload, the price of the ready mixed fertilizers can be reduced to a point where the amount saved by home mixing would not be appreciate.

Details on how to mix fertilizers can be secured in Bulletin No. 364, entitled "Manures and Fertilizers."

FERTILIZER RATIOS

In considering the individual effects on plant growth of the three fertilizer elements, it is observed that they are complementary to one another. This inter-relationship of influence of one nutrient upon another is very important in the economical utilization of fertilizers.

The ideal condition is to apply fertilizers of the right kind and amount to supplement soil deficiencies, taking into consideration the feeding characteristics of the crop to be fertilized, the whole blending together in the right ratio to form a balanced ration for the crop. A deficiency of any one nutrient will seriously interfere with the absorption of the others. If added in excess, detrimental results may follow

in the form of an unbalanced growth and what is known as luxury consumption — that is, the plants consume more than they actually require.

In making recommendations of fertilizers for various crops, it has been the custom to name specific analyses, e.g., 4-8-10 or 5-8-7, etc. To name specific analysis only presents freedom of choice of similar analyses, and thereby places undue emphasis on a definite mixture. For instance, 4-8-4, 5-10-5 and 10-20-10 all supply a similar relationship of nitrogen, phosphoric acid and potash. If 2,000 lbs. of 4-8-4 is recommended, the grower can apply precisely the same amount of ingredients ($\text{N-P}_2\text{O}_5\text{-K}_2\text{O}$) in 1600 lbs. of 5-10-5 or 800 lbs. of 10-20-10.

Fertilizer recommendations in this bulletin have been stated as specific mixtures. Sometimes these mixtures are not always available; and others containing a similar ratio of Nitrogen, Phosphorus and Potash are available and would be suitable to use, providing the same amount of plant food nutrients are applied per acre.

STORAGE OF FERTILIZERS

At times it is necessary to keep fertilizers from season to season, and often they become very hard and difficult to handle. Home mixed fertilizers should never be kept for any length of time owing to chemical reactions taking place involving a possible loss of plant food and the whole mass becoming very hard. Well made ready mixed materials will not deteriorate or harden to any extent if stored in a dry place on boards and not piled. It is always advisable to plan to purchase a new supply each season.

IMPORTANCE OF LIME

Vegetable crops are usually grown under rather wide conditions of soil varying in reaction and lime requirement. Owing to the intensity of culture, the reaction of the soil is an important factor because the availability and utilization of the fertilizers added and the growth and quality of the crops are affected by the degree of soil acidity.

If the soil is too acid, the actions of beneficial soil organisms that bring about the decomposition of organic matter, formation of nitrates and fixation of atmospheric nitrogen are diminished.

The efficiency of fertilizers, especially ammonium sulphate and super-phosphate, are greatly reduced on acid soils and injurious soil-borne diseases of plants such as club root of cabbage, etc., flourish.

It is impossible to give an optimum soil reaction for any given crop because the type of soil, amount of natural organic matter in it and farm manure added will influence the need for lime and the success of growth under different degrees of acidity. Also the choice of fertilizer used in heavy annual applications will influence the need for lime and soil reaction. Materials leaving an alkaline or acid residue will materially affect the soil reaction within a comparatively short time.

Generally speaking, crops will tolerate more acidity on soils well supplied with organic matter or having a high clay or silt content than those having an open sandy nature; also that the equal applications of lime will have a more pronounced effect in neutralizing soil acidity on the latter type of soil than on the former type. Thus heavy manuring and the use of fertilizers leaving an alkaline reaction will often obviate the need for lime on some soils.

The majority of vegetable crops prefer a neutral to alkaline soil reaction as they have a weak feeding power for lime. Crops can be classified in their ability to tolerate soil acidity.

RELATIVE SENSITIVENESS OF PLANTS TO SOIL ACIDITY (F. E. BEAR)

VERY TOLERANT	TOLERANT	SENSITIVE	VERY SENSITIVE
Beans	Carrot	Brussels Sprouts	Asparagus
Potato	Corn	Cabbage	Red Beet
Radish	Cucumber	Chard	Celery
Watermelon	Endive	Egg Plant	Leek
	Pea	Horse Radish	Lettuce
	Pumpkin	Muskmelon	Onion
	Rhubarb	Turnip	Parsnip
	Strawberry		Pepper
	Tomatoes		Salsify
			Spinach

Considering the slight expense in time and labour required and the cost of a "Reactosoil" test kit for testing soils, every grower should test his soils to determine its lime requirement before applying lime. If lime is necessary, use some form of finely ground limestone at the rate recommended as shown by the test. This soil testing kit containing full instructions, can be obtained through the Department of Chemistry, Ontario Agricultural College, Guelph, for twenty-five cents.

For a further comprehensive treatment on the subject of soil reaction and lime, the reader is referred to Extension Circular No. 31, 1935, issued by the above Department, entitled "Lime and Its Uses."

BULB CROPS

ONION, CHIVE, LEEK, GARLIC, WELSH ONION, SHALLOT

The fibrous roots of the full grown bulb are largely in the surface six to eight inches of soil and extend about six inches from the plant with a considerable percentage of the roots at three inches from the soil surface. The roots require a soil always possessing moisture; while the early growth particularly demands an ample supply of water in the soil.

SOIL AND CULTIVATION: A well worked muck soil is most desirable, but any loose, friable soil containing plenty of plant food and neutral to alkaline in reaction, will produce good crops of onions. Heavy clay soils are not suited to onion growing. Large applications of manure or plowing down heavy cover crops will put the heavy soil in condition to grow onions in the course of time. Thorough preparation of the soil previous to planting or sowing is more important than with most other crops. A fine seed bed — six to eight inches deep — is necessarily prepared previous to seed sowing to allow the contact of the seed and small fine roots with the soil as to secure plant food and moisture. Fall plowing combined with spring disking and harrowing followed by rolling or plank dragging are employed to make the soil fine, smooth and firm for seeding. Cultivation should be shallow, especially late in the season, when the cultivator should be kept away from possible bruising of the bulbs.

THE DRY BULB OR MAIN CROP: This crop is mostly used for table stock and winter storage; and usually produced from seed. The seed should be sown as early in the season as the soil can be prepared to the depth of half an inch, with rows about sixteen inches apart, at the rate of four to six pounds per acre. Sowing thinly and thus omitting the expensive operation of thinning is much preferable to the combination of thick sowing and thinning. Thinning, when conducted, is preferably done before the onions have obtained the size of a leadpencil. The soil should be moist during thinning. When large, uniform bulbs are desired, a three-inch space between the onions is provided.

Yellow Globe Danvers, Southport Yellow Globe, with yellow outer scales and firm white flesh, are the principal varieties for this crop. Red Globe, Red Weatherfield, White Globe and Ebenezer white fleshed are other varieties grown in much less quantity.

Onions sets are used to a limited extent for the production of the Main or Dry Bulb Crop, varieties Yellow Globe Danvers or Southport Yellow Globe. These sets provide an earlier crop than that produced from seed. Sets, $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter are the most desirable size. Small sets produce weak plants and one larger than $\frac{3}{4}$ inch in diameter is very likely to produce seed stalks and thus ruin the marketing value of the crop. Sets are planted by hand or a special machine; and are planted three inches apart in the row, with rows the same distance apart as for seed sowing.

SPANISH TYPE OF ONION: Large, mild-flavoured onion, varieties of this type comprise the Valencia, Denia and Riverside Sweet Spanish. To attain the natural



A Field of Transplanted Onions

size the seed is sown in flats March first, in rows two or three inches apart. When the seedlings are about four inches high the tops are clipped back; and the clipping is conducted weekly to maintain that height until planted into the field in May to produce a well-rooted plant. The young plants are set six inches apart in the row, with rows sixteen to eighteen inches apart.

DUTCH SETS: The seed of the Ebenezer variety is recommended for the production of sets. The seed is sown on fertile, sandy land, during early spring at the rate of forty to eighty pounds per acre in rows three to four inches wide and about twelve inches apart. The crowded field conditions produce small bulbs or sets. Maturity of the sets ensues in late summer when they are cured and stored for use the following spring.

Onion sets are used for the production of green onions in the spring, usually planted in rows fourteen to sixteen inches apart and about half an inch apart in the rows.

The Egyptian or tree onion produces a stalk at the top of which is a cluster of sets. The sets are quite hardy, and are planted in September, producing green onions

the following spring. These top sets will be grown for many years if the plants are not disturbed. The old clumps give the earliest green onions.

The Potato or Multiplier onion bulb splits into parts which are sometimes planted in September for early spring green onions.

The White Welsh perennial onion, grown as an annual or biennial, forms a small enlargement at the base of the stem. This onion is propagated by seed or division of the clumps. The seed is sown in early September in rows fifteen inches apart. Thinning should be done at about two inches apart. Early green onions are produced the following spring.

The Leek is a biennial which is grown for its blanched tender leaves, milder in flavour than the onion. Plants from seed are grown in a hotbed or greenhouse and planted in the garden soil; or the seeds are sown in rows about sixteen inches apart and thinned to four or five inches apart in the row.

The plants are blanched by banking with soil, working up the soil gradually as the plants grow. The plants easily decay when young so that banking up the soil must not be done too early. The leek is used raw alone, in mixed salads and in soups.

Garlic produces a group of small bulbs enclosed in a thin skin. These small bulbs, called cloves, are used for propagation. The seed stalk is similar to that of the onion, and produces seeds and sets on bulblets in the same head. The seed is not usually used for propagation. The cloves are planted three to four inches apart in rows fourteen to eighteen inches apart. The bulbs are pulled when the tops are ripe; dried on the soil; and the tops woven together in braids. This crop is mostly used as flavouring in soups.

The shallot is a perennial whose bulb, when planted, divides into cloves which are attached to each other. These cloves are planted as is Garlic. When the leaves commence to wither, the bulbs are pulled, dried, divided and stored in a dry, cool storage. They are used for mild seasoning, and the leaves are eaten when green.

Chive is a perennial, producing small oval bulbs in a compact mass, and grows in thick tufts. Propagation is achieved by division of the tufts. Replanting the tufts about every three years is most satisfactory. The leaves of the plant are used for seasoning, and are harvested by cutting off with a sharp knife.

PICKLING ONIONS: Seed for this crop is sown at about thirty pounds of seed per acre by a garden seed drill with a spreader attachment for broadcasting the seed in rows three to four inches wide and sixteen inches apart. The close proximity to one another of these onions in these rows provides the desirable small sized onions for pickling.

Silver Skin—Is used more than the Barletta variety. This crop is grown on moderately rich, medium to heavy sandy loam or silt loam, and occasionally on muck soil.

FERTILIZERS: On light sandy soils 15-20 tons of well rotted manure should be applied in the autumn. Previous to planting, from 1,000 to 1,500 lbs. of a 4-8-10 or 5-10-10 fertilizer is recommended. On well decomposed muck soils, a 2-8-16 or 2-8-24 at the same rate is advised. Recent investigations show that it is advisable to apply part of the fertilizer broadcast and disc in previous to sowing, and part two inches beneath the seed.

PREPARATION FOR MARKET: Green onions are pulled, washed and bunched as soon as large enough. A good length of blanched or white tender stalk is desired. Only a limited amount is harvested at a time. A continuous supply is desired and plantings are arranged accordingly. Picklers are pulled and dried in field if weather permits or in sheds if weather is bad. Shallow trays are used and the tops are rubbed off after they become dried. Care must be taken to prevent the bulbs from becoming greened by exposure to the sun. A bright white skin is desired on pickling onions and they should be graded for size, one-half to one inch in diameter being most popular sizes. Onion Sets are harvested in much the same way except that exposure to sunburn is not so serious. The dry bulb onion or main crop, of course, is not harvested until fall or when the tops ripen down. Frequently the tops are rolled down to hasten ripening, but this is of doubtful value as injuries to the necks may cause rot later. The bulbs are pulled usually by hand and placed in windrows to cure and dry for a day or two. They are then placed in trays, stacked up in field to finish drying when they are taken to the topping machine and tops removed and bulbs run over graders, where the different grades are put in sacks to go to storage, to complete the curing process or may be placed directly on the market.

COLE CROPS

CABBAGE, CAULIFLOWER, SPROUTING BROCCOLI, BRUSSELS SPROUTS,
CHINESE CABBAGE, KOHL RABI

PRODUCTION OF YOUNG PLANTS: Seed of early cabbage and Brussels Sprouts is sown eight to nine weeks before field planting. Seed for early cauliflower and Sprouting Broccoli is sown about one week later than that of early cabbage. In compost soil situated in containers as described in the discussion of compost soil, in the greenhouse or hotbed, seed sowing of these crops is conducted in rows about two inches apart and about one-quarter of an inch deep and covered with sharp sand, or compost soil mixed with sharp sand. At once subsequent to sowing and a thorough watering these seeds are provided with a temperature of 70 degrees F. From the time the two seedling leaves are produced until the first transplanting fifty-five degrees F. are maintained for the plants.

The first transplanting is performed soon after the first true leaf appears. The first two leaves produced are seedling leaves, and all subsequent leaves are called true leaves. At this transplanting the seedlings are planted into moderately rich compost soil in three-inch clay pots where they develop into plants suitable for field planting. Instead of using pots the seedlings may be planted two inches apart each way in the compost soil in flats. When the young plants in these latter flats meet between the rows they are again transplanted to compost soil with plenty of fibrous material in other flats three inches apart each way. Both of these two methods are satisfactory. Immediately after the first transplanting and until placing into a coldframe, 50 degrees F. is applied to the plants.

Young cauliflower and Broccoli plants are more tender than those of cabbage. Immediately after sowing, water thoroughly. The compost soil should be at all times kept moderately moist. When the plants have come through the soil temperatures of 55 to 60 degrees F. are maintained until the first transplanting.

The seed for the late crops of cabbage and cauliflower is sown thinly. For the production of young plants for the late cabbage and cauliflower crops a moderately rich, loose, well prepared soil in the field or garden should be used. Sow seed thinly with a garden seed drill about five to six weeks previous to field planting. The

seedling rows are about fifteen inches apart and the small seedlings are often thinned to about one-quarter inch apart in the row. The young plants are allowed to remain in the seedling row and grow until transplanting to the field, about the last week in June. Only the well developed plants should be planted.

HARDENING OFF

Hardening off vegetable plants or other plants is a term referring to a treatment which hardens the tissues of the plants to withstand unfavourable conditions after transplanting into the field. These unfavourable conditions may be frost injury, whipping, drying winds, disease or insect injury and other unsuitable conditions. Well hardened, stocky young plants are necessary instead of soft tender plants. Hardiness is increased by a material check in growth. Plants are hardened by either of the following methods:

Method One—Subjecting them to comparatively low temperatures for a week or ten days before transplanting to the field.

Method Two—Permitting the soil in which the plant grows to become dry.

Method Three—A combination of methods one and two by the application of comparatively low temperatures and withholding of water.

Low temperatures are obtained by heat reduction and increased ventilation in the greenhouse or hotbed. Considering that hardening is secured by checking the growth of the plant by any method low temperature is not necessary for hardening. Thus placing plants in coldframes is not necessary because hardening can be secured in the greenhouses or hotbed by withholding water as satisfactorily as by placing the plants in the low temperature of the coldframe. However, method three is the most common.

CABBAGE

The cabbage plant is a biennial, producing a short stem and a terminal bud or "head" the first year and branches bearing seed the second year. The leaves are somewhat ovate and circular. Usually the taproot is injured in planting; and then a main root usually grows in a downward direction into the soil. From the bottom of the stem numerous well branched laterals with fibrous roots grow. When half grown the roots have been found to be as deep as twenty-two inches; the soil, well filled with fine branching roots at a depth of fifteen inches; lateral roots extending eighteen inches from the plant; fine roots filling the surface soil within a radius of twelve inches from the plant. At maturity some roots were three feet deep in the soil; the roots, well filling the soil to a depth of thirty inches; the principal lateral roots growing nearly horizontally, some to a length of three feet from the plant.

CLIMATE: Cabbage is a cool season crop, demanding plenty of moisture.

EARLY CROP

SOIL AND CULTIVATION: A well drained, rich sandy loam is preferable to secure warmth and earliness. However, sufficient soil moisture is always necessary. Preferably the soil should be fall plowed, then spring plowed, disked and harrowed to secure good tilth. Immediately after planting a fairly deep cultivation is given to loosen up the soil for easy penetration of the roots. Subsequent cultivations are quite shallow, effecting weed control. A careful examination of the proximity of the roots to the soil surface and cultivated area at each cultivation with this and every

vegetable crop will materially aid in preventing damage to the roots by undue deep cultivation.

PLANTING: Well hardened cabbage plants can withstand a temperature of ten to fifteen degrees of frost for a few days and thus quite early spring planting is conducted, about the first of May. The plant possesses five to six well developed leaves at planting time. Early plants are set about eighteen inches apart in rows thirty inches apart. Machine transplanters are used for large areas. Hand transplanting is conducted by using a dibble or trowel.

LATE CROP

SOIL AND CULTIVATION: A large yield is the chief aim. Silts and clay loams, neutral-alkaline in reaction, are preferable as these heavy soils are rich and retentive



Late Cabbage in London District

of the necessary soil moisture. Muck is used satisfactorily for this crop. Spring plowing is done to conserve all possible moisture for the crop. Cultivation subsequent to planting is the same as for the early crop.

PLANTING: Distances vary from two to two and one-half feet apart each way.

MARKET PREPARATION: Late cabbage is permitted to attain full size and the desirable hardness before cutting with a knife at the top of the stem just below the head. If selling immediately or storing remove the leaves which do not fit firmly about the head at time of cutting.

CABBAGE VARIETIES: The earliest variety is Jersey Wakefield which has small pointed firm heads.

Golden Acre is the principal and most largely planted early commercial variety, producing a moderately sized, firm, round headed cabbage, and is only a few days later than the Wakefield.

Copenhagen Market is later and larger than the *Golden Acre*. The head is round and compact.

Short Stem Danish Ballhead is grown for the main crop for winter storage be-

cause it keeps more satisfactorily than any other variety. The head is medium in size, round and distinctly solid.

Glory of Enkhuizen is a flat, large, moderately solid head, and is grown as a fall crop. However, the Danish Ballhead variety is more satisfactory.

The Red Rock is usually grown as a late fall red variety, with a firm, medium sized head, much resembling that of Danish Ballhead.

Savoy Varieties possess distinctly wrinkled, dark green leaves. The quality of this cabbage is superior to the smooth leaved varieties, but is grown to a comparatively limited extent.

CAULIFLOWER

Cauliflower is a biennial. Terminating the main stem is the edible head or curd composed of fleshy flower parts. Attached to the main stem at various intervals underneath the head are cabbage-like leaves. The taproot is usually injured in transplanting so that the large branching root system is composed of many laterals and network of smaller roots, extending two and one-half feet in depth and about two to two and one-half feet on all sides of the plant.

CLIMATE: Correct conditions of climate are more important than efficient soil characteristics. Cauliflower grows best in a comparatively cool, moist atmosphere. In the field, extremely low temperatures throughout the early growth of the plant, and unusually warm weather and drought cause premature heading or "buttoning". Extremely high temperatures during the formation of the heads may cause them to become spreading and ricey—unsatisfactory marketable specimens. A well distributed rainfall or irrigation is requisite to supply sufficient moisture in the soil to provide the necessary uninterrupted, steady growth. In Ontario early crops are grown to have the heads form previous to the hot mid-summer weather, and the late crops are produced to have heading commence with the lower temperatures of September and October.

SOIL AND CULTIVATION: A rich, moderately deep, loamy moisture retentive soil is desired. The early crop is usually grown on rich sandy loam with an abundance of organic matter. The late crop is produced on the above sandy loam and silt loams in preference to clay loams which, however, produce satisfactory crops if well supplied with organic matter. Muck soils are also used with satisfaction.

At transplanting time to the field and throughout the entire life of the plant in the field an ample amount of soil moisture is requisite for the required steady continuous growth. Consequently, a large amount of organic matter should be present in the soil as a water-holding power. Organic matter also aids in loosening up heavy soils and making the sands more compact. Efficient drainage is very necessary. The organic matter should be well decayed before planting so that late fall or real early spring plowing is conducted to aid in saving the moisture in the soil.

Cultivation should commence immediately after the plants become established in the field following planting, and be conducted until the plant shows signs of heading or until the leaves are broken off by the cultivator between the rows. The first cultivation after planting is moderately deep. The subsequent cultivation should be more shallow than each previous cultivation so that quite shallow cultivation is conducted as the plants reach maturity to prevent root injury. Hoeing is necessary to aid in the control of weeds and loosening the soil.

EARLY CROP

PRODUCTION OF YOUNG PLANTS: Immediately after seed sowing, with a fine spray water thoroughly. When the plants have come through the soil temperatures of 55 to 60 degrees F. are maintained until the first transplanting.

FIELD PLANTING: Planting is performed late April or early in May when danger of hard frost is past. The rows are usually two and one-half to three feet apart; and the plants eighteen to twenty-four inches apart in the row. Retain as much soil around the roots as possible.

LATE CROP

FIELD PLANTING: Plants are set into the soil at distances usually twenty-four inches apart in the rows which are three feet apart.

MARKET PREPARATION: The market demands a pure white, solid, compact head showing no spreading, ricey or leafy heads. The overmature head is characterized by the parts of the head separating from each other or spreading. The ricey head is granular in appearance and lacking in compactness, caused by the lengthening of the tiny stalks bearing the flower buds. The badly spread head is of less market value than the ricey head. Small green leaves grow between the parts of the head, usually due to poor seed or unfavourable growing conditions.

All sunlight must be excluded to obtain the white head. When the head is small in size the inner leaves curve over it and protect it from the sun. When the inner leaves first commence to lift themselves, thereby exposing the small head—about two to four inches in diameter—to view when looking down on the plant, the outer leaves are brought over the head and tied with string or strong rubber bands. During the warm weather the heads may be suitable to harvest two to four days subsequent to tying; while cool weather may lengthen this time to one or two weeks.

HARVESTING must be conducted when the head is white, compact, solid, showing no overmaturity indicated by spreading or riciness of the head. Do not sacrifice the correct stage of maturity and harvesting to secure size. Medium sized, compact, white heads possess more marketable merits than the large somewhat spreading heads lacking the white colour. The stem is cut to have eighteen to twenty leaves. The leaves are cut so that they project one to one and one-half inches above the head. These circles of cut leaves protect the head from injury in the various phases of shipping and marketing. Cauliflower are best packed in one tier crates for shipping.

VARIETIES: *Snowball*, especially the Extra Early variety, is the recognized early commercial cauliflower. *Early Dwarf Erfurt* is about twelve days later than the *Snowball*. These are the two principal varieties grown either as a late or early crop.

BROCCOLI

The Sprouting Broccoli, slightly grown in this country, produces leaves, more ragged in appearance than those of the cauliflower; and develops a longer stem. The central head or cluster of green flower buds, three to six inches in diameter, is formed at the top of the main stem. After the central head is removed other heads, two to four inches in diameter, are produced on lateral shoots growing from the axils of the leaves. These small heads are produced for a number of weeks. The stems are green and the heads are dark blue green in colour for the best types. Cool weather for field growing conditions is best as warm weather is negative to the best development of heads.

The soil and cultivation requirements are practically the same as those suitable for cauliflower. One hundred to one hundred and twenty-five days are necessary from seed sowing to heading.

The plants are planted in rows in the field eighteen to twenty-four inches apart in the row, with rows thirty-six to forty inches apart.

MARKET PREPARATION: This Broccoli should be harvested when the buds of the flower bud clusters are well developed, and previous to the appearance of the flower petals. This is the essential stage for marketing because the more advanced development causes over-maturity with tough and hollow pithy stems. Harvesting is conducted by cutting the stem immediately below the branches of leaves and flower bud clusters.

VARIETIES: *The Italian green sprouting type* is recommended in preference to the white-sprouting or purple-sprouting varieties.

BRUSSELS SPROUTS

The plant is a biennial possessing an erect unbranched stem eighteen inches to two feet in height at the top of which are leaves nearly as long as broad. It is grown for the small edible sprouts, lateral buds or small heads about an inch in diameter situated on the erect stem in the axils of the leaves. The root system is similar to that of the cauliflower.

Climatic, Soil and Field Cultivation requirements are practically the same as those of the cauliflower. The plants are set in the field three by two and one-half feet.

MARKET PREPARATION: About three months after setting in the field harvesting commences. The sprouts, about one and one-half inches in diameter, at the base of the stem, mature first and are harvested when the leaves just commence to become yellow. At picking time the leaf in the axil of which the sprout grew, is removed from the stem. Numerous pickings are conducted. The stem increases in length and forms sprouts in conjunction with the removal of the lower sprouts and leaves.

At the commencement of freezing weather the plants are pulled or cut at about the surface of the soil and then stood upright in a cool cellar or shed, packed tightly together and covered with hay. Freezing is not injurious if thawing is gradual while alternate freezing and thawing is disastrous. The sprouts are picked as desired, the outer yellow leaves removed and sold in quart berry boxes considerably.

CHINESE CABBAGE

Chinese Cabbage is an annual and not a true cabbage. The *Petsai* varieties have a similar appearance to Cos lettuce, with its compact, elongated head, with green, thin, fully veined, somewhat wrinkled leaves. This is a cool season crop and is grown in spring and autumn. As a spring crop the seed is sown and plants grown similarly to early cabbage. However, no growth checks must be allowed, and usually field planting is conducted about four weeks after seed sowing. The seeds for the autumn crop are usually sown in the soil on which the crop is produced about the middle of July. When good sized seedlings are present thinning about twelve inches apart is conducted. Rich sandy loam, medium clay loam and muck soil well retentive of soil moisture are suitable.

HARVESTING: At the full development of the heads cutting from the stem similar to cabbages is conducted and the loose outer leaves removed.

COLE CROP FERTILIZERS

These plants are heavy feeders on all three important plant food constituents, especially phosphoric acid. On light sandy soils from 20 to 25 tons per acre of well rotted manure should be applied in the autumn and well worked into the soil. At the time of planting apply from 1000 to 1500 pounds of 4-8-10 or 4-10-8 fertilizer, or a similar mixture. On heavier soils receiving similar manuring, a 2-12-6 or 2-16-6 fertilizer applied at the same rate per acre will be more suitable. On muck soils which are particularly low in phosphorus and more especially potash, 1000 to 1500 pounds of 2-8-16 or 2-8-24 mixture will give good results.

It is important that a supply of nitrogen be available for these plants especially during the early growing period. Therefore, if the season is cold and wet or the soil acid in reaction, side dressings of 150 to 200 pounds per acre of either nitrate of soda or ammonium sulphate would be advisable.

Recent investigations have proved that applying the fertilizer in bands 2 inches from each side of the plant and 2 inches below the surface will give the most economical results.

KOHL RABI

The turnip-like enlargement of the stem above the soil surface is used. To secure good quality and no stringiness it must grow quickly without any check. Any suitable rich garden soil well prepared and fertilized, is suitable.

Seed is sown in rows eighteen to thirty inches apart and plants are thinned to eight inches apart in row. Sowings at intervals of about two to three weeks will produce a continuous amount of tender material.

VARIETIES: *Purple Vienna, White Vienna.*

HARVESTING is conducted when the swollen stem is two to three inches in diameter. This vegetable is used to a limited extent in this Province.

VINE CROPS

Cucumber, Muskmelon or Cantaloupe, Pumpkin, Squash, Watermelon, Citron, Marrow.

CUCUMBER

The cucumber is an annual warm season crop, maturing in about seventy days. The root system is shallow and quite extensive throughout the soil.

SOIL AND CULTIVATION: Nearly any type of soil is satisfactory for cucumbers. For the early crop a sand or sandy loam soil is necessary. However, where high yields and comparatively long producing period are the objective the heavy sand loam or clay loam is used to the best advantage, due to the presence of moisture and plantfood supply. The soil should always be well drained but retentive of moisture, particularly for the late crop. Any of these types of soil should contain plenty of organic matter.

Frequent cultivations should be shallow, and are practised until the growth of the plants between the rows prevents. Weed control is essentially effective by cultivation with frequent hand hoeing.

PRODUCTION OF YOUNG PLANTS FOR THE EARLY CROP: This crop is grown only when a high price is anticipated. About six weeks previous to field planting the seed is

sown in sand loam soil in 2½ or 3 inch clay pots, berry boxes, paper bands or in sods as for cantaloupes. When the seedlings have developed to the production of the first few leaves all but two well developed plants are cut off, and these two good plants are developed for field setting. Temperature and watering demands for the growth of young plants for the early crop are the same as for the cantaloupe early crop. Cucumber young plants are more easily transplanted than those of cantaloupes but have the same size at field planting time.

Another method for growing these young plants is: About six weeks previous to planting in the ground beds either one or two seeds are sown in the compost soil or other suitable soil in a two-inch thumb-pot; and lightly covered with soil which is thoroughly watered. When the two seedling leaves are produced one of the plants is cut off so that only one plant per pot is grown to the transplanting stage. Ventilation must not permit any draughts of air or rapid temperature changes. The soil should be moderately moist and never allowed to become dry. Transplanting the young plant from the thumb-pot to the compost soil in the four-inch pot is conducted when the first true leaf is commencing to show. The plant remains in this four-inch pot until three or four well sized true leaves and an adequate root system are produced. After hardening off field planting is conducted.

THE MAIN CROP: The cucumber plant is usually killed by frost, and it grows best during the warm summer weather. Seed is usually sown out-of-doors about May 24th, as a warm soil is requisite for good germination.

Drills and hills are used for the production of this crop. Drills are now more generally used than hills. When the drill pan is utilized the seeds are sown by a garden seed drill in a continuous row at the rate of 2 to 3 pounds to the acre. The rows are from four to six feet apart and when the plants are good sized seedlings thinning is conducted to effect a spacing of 15 to 18 inches apart in the row. Hills are spaced from 4 - 6 feet apart each way. A number of seeds are sown in each hill and then the seedlings are thinned to two healthy plants per hill.

VARIETIES FOR SLICING: *Early Fortune* and *Early White Spine* possessing a rich dark green colour about 9 inches long with firm white flesh. *Davis Perfect*—Early White Spine type; ten to twelve inches in length; dark green colour with crisp white flesh. *Vaughan*—a main crop, white spine variety, about 10 to 12 inches long, dark green colour, firm white flesh.

HARVESTING: For slicing cucumbers this crop is picked when from 6 to 10 inches in length. Frequent pickings provide this marketable product with distinctly green colour, showing no ripening, with the stem attached to the fruit.

MUSKMELONS

The cantaloupe or muskmelon is grown extensively in several areas and is found in all small gardens. The season extends from early August until late in the fall. The fruit is perishable and does not store well, so the season is limited as the crop cannot be grown during the winter months successfully in the greenhouse. This is one of our most tender vegetable crops and requires special care. The plant is an annual whose root system consists of a short, fairly thick tap root from which extends, at considerable length, many lateral roots, equipped with fibrous roots, about six inches below the soil surface.

CLIMATE: An abundance of sunshine with warm days and nights is necessary.

PRODUCTION OF YOUNG PLANTS: It is necessary to grow the plants in the greenhouse or hotbed and transplant to field about May 24th for the earliest melons. The young plants, unless transplanted as young seedlings, should not be transplanted, as the new roots develop very slowly. The seed is sown about April 15 to 20th in hotbeds or greenhouses in good compost soil, situated in paper bands, clay pots or inverted sods. The sods, preferably of fertile, sandy loam soil, about four inches square and three inches thick, are placed inverted immediately adjacent to one another. Usually three or four seeds are planted in each pot or sod and thinned to leave two good plants when they have commenced to develop the first true leaf. These two young plants are not removed from the soil in the pots, paper bands or sods, but allowed to grow in this soil until suitable for field planting. At this time the soil is maintained around the roots by careful watering, so that the removal to the field location does not disturb the roots.

The young plants are grown in temperatures of 75 degrees F. on bright days and 70 degrees F. at nights and cloudy days. Watering must be carefully done in bright weather early in the day. Hardening off is conducted in the hotbed or greenhouse by plenty of ventilation and a minimum water supply; while field planting is done at the development of four true leaves after frost danger.

SOIL AND CULTIVATION: Well-drained light or medium heavy sandy loam soils with plenty of organic matter are best and usually used. With any soil the plant must be warm with plenty of sunshine. An early location is desired, such as a sheltered field or a south side of a ridge, where the soil warms up early and where late frosts are not likely to injure the young plants. Cultivation should be shallow and only frequently enough to keep down young weeds, and should be discontinued as soon as the vines are well spread. Weeds which grow later should be pulled by hand.

PLANTING: Some growers sow seed in an open field soil near the end of May and thin out the young plants. This plan succeeds well on early ground and the crop usually ripens before frost unless it is a very late variety. Field planting distances with two plants at one planting spot, consist of 3½ by 5, 4 by 5, 4 by 4, 5 by 3 feet and sometimes 6 by 6 feet.

VARIETIES: *Golden Lake Champlain*. *Lake Champlain* are salmon fleshed early varieties of fair quality but poor shippers. Suitable for local and roadside markets.

Sugar Salmon. a salmon flesh of good quality and yield. Satisfactory shipper for Eastern Canadian markets and considerably used in the Aldershot commercial district.

Hales Best and *Honey Rock* are salmon fleshed. good quality melons, possessing good yielding and shipping qualities; and used in commercial districts, although slightly later than the Sugar Salmon.

Burrell's Gem, salmon fleshed; and *Hearts of Gold* are about two and a half weeks later than Hales Best, but of satisfactory quality as shipping melons.

MARKET PREPARATION: The quality of melons depends on uniform growth and proper ripening. Melons picked too green or immature will not ripen with good flavour and texture. Melons should ripen on the vines for local markets. The stem will separate from the melon with a light pull, when ready for market. Melons for distant markets may be picked just before the stem separates easily. It is best to pick over a patch every day, preferably in the morning, as melons are cool then and will keep longer than if picked during the heat of the day. The melons are graded as to size and packed in crates for distant shipments. Large baskets or hampers are

used for local markets. Melons taken off diseased or dead vines usually lack quality and are undesirable.

PUMPKIN, SQUASH, MARROWS

Pumpkins are usually grown in limited quantity as the demand varies; the small pie pumpkins being most popular on the market. Canning factories sometimes contract for considerable quantities, but this demand is irregular. Squash are of more importance on the market and meet with greater demand. There are many varieties and a fairly wide use is made of them and they store well. Squash are grown in considerable quantity by most gardeners. Marrows are quite popular and are used mostly during the summer season.

PLANTING: Seed is usually sown outside either in hills six to twelve feet apart or some seed may be put in the corn hills when planting corn. Seed may be sown in rows and the young plants thinned to the desired distance. Any good well-drained soil will produce good crops of pumpkins, squash and marrows.

VARIETIES: *Pumpkin Pie* (various strains), *Connecticut Field*.

SQUASH: *Summer: Early White Bush Scallop, Crookneck, Giant Straightneck; Squash: Winter: Warty Hubbard, Golden Hubbard, Boston Marrow. Table Queen* of excellent quality for baking and serving in halves.

Marrow: Common Vegetable Marrow and Bush Marrow.

WATERMELONS

This is not a large crop in Ontario but is found in many home gardens and in the southern sections, frequently good field crops are produced and sold on the local markets.

SOIL AND CULTIVATION: A light well-drained soil gives good results. It should be rich yet not so rich as to make excessive vine growth. Cultivation should be shallow but thorough until vines cover soil.

PLANTING: As a rule seed is started in beds or greenhouses and the young plants set in field after all danger of frost is past. On protected and more favoured plots the seed may be sown directly in drills or hills and the young plants thinned to stand the desired distance, which is from four to eight feet apart.

HARVESTING: The melons are best ripened on the vine and one requires considerable experience to judge when a melon is ready to harvest. The colour of the pale spot and the sound on tapping with knuckles as well as the curling of the stem, are indications.

VARIETIES: *Cole's Early, Harris Earliest, Kleckley Sweet, Tom Watson.*

CITRON

The citron much resembles a small watermelon, round in shape, and of light green colour. The flesh is not edible and the rind is canned. The cultural requirements are practically the same as those for watermelon.

FERTILIZERS:—*Melons, Pumpkins, Squash, Marrows, Cucumbers and Citron:* These crops demand large quantities of water combined with relatively large amounts of available plant food.

If manure is plentiful, applications of 30 to 40 tons per acre are advisable. This could be applied broadcast. If, however, it is deemed necessary to conserve manure, smaller amounts could be applied in a trench 24 inches wide by 12 to 15 inches deep, covered with soil and the seeds planted on the top. To balance the plant food, apply 750 to 1000 lbs. of 4-12-6 or 3-10-5 fertilizer around the hill at the time of sowing the seed or planting the young plant. If manure is not available, fertilizers high in nitrogen and potash should be used, such as 4-8-10 or 6-8-10, at 750 to 1000 lbs. per acre.

GREENS

SPINACH, CHARD, NEW ZEALAND SPINACH, KALE.

SPINACH

This is our most important "greens" crop. Demanding relatively cool weather it is grown extensively as an early spring and late fall market crop as well as being grown under contract for canning factories, in considerable quantities. It is usually found in the home garden. Spinach possesses a distinct taproot which penetrates somewhat deeply into the soil. Major branches from this taproot in about the 6 - 8 inches of surface soil extend from the taproot about 10 inches or less and then turn downward into the soil. On these major branches are numerous rootlets. As an annual the spinach possesses two distinct stages of growth. Subsequent to germination of the seed a crown is formed adjoining the soil surface. This crown is actually a longitudinally compressed stem. From this stem the edible leaves arise in practically the same plane. After the crown and the edible leaves have developed the stem increases in length, branches, and forms flower stalks. The latter bear leaves and clusters of flowers in the axils of the leaves and stems. This flower stalk production is usually called "bolting" or "shooting" to seed; and concludes the canning and market value of the spinach crop.

SOIL AND CULTIVATION: A light sandy soil is best for the early spinach crop but any loose friable soil slightly acid to neutral in reaction will produce a good crop. It must be well drained and should contain plenty of humus and available nitrogen. Shallow cultivation is conducted.

SEED SOWING: Seed is sown thinly in drills, twelve to eighteen inches apart, using from sixteen to thirty pounds of seed, depending mostly on the germination quality of the seed.

THINNING: The plants may be thinned to stand three to six inches apart. Thinning is not practised with the canning crops. The late or Fall crop should be sown in midsummer sometime in August, depending on locality and season. Spinach will not develop properly during the long days of midsummer as the plants produce stalks and leaf growth is checked.

HARVESTING is done by cutting the root just below the crown and removing all spoiled leaves. The remaining leaves are left intact and placed in hampers and handled usually in bulk.

VARIETIES: The following three excellent quality varieties are effectively resistant to bolting:

Long Standing Bloomsdale—Maturing in about fifty days; savoyed leaves broad and rounded, deep green, and rapid grower. Excellent for home and market garden.

King of Denmark—the largest standing spinach variety; a quick grower; large savoyed leaves moderately broad; maturing in forty-five days. Very suitable for home gardens and canning.

Nobel—smooth, large green round tipped, broad tender leaves. Very desirable for canning. Suitable for use in 40 to 43 days.

Virginia Savoy—Not a long standing variety; blight resistant; high quality; best adapted to late fall crops and for wintering over for the very early spring crop.

Fertilizers for Greens are the same as mentioned for lettuce.

SWISS CHARD

This is a useful plant for supplying greens during the midsummer. The leaf stalks are used in a similar way to asparagus. It is canned like Spinach and is usually found in all home gardens.

PLANTING: Seed may be started inside and plants transplanted, but mostly the seed is sown directly in soil in rows eighteen inches apart or wider, for horse cultivation. The plants should be thinned to eight or twelve inches apart.

Any good rich soil will produce a good crop of Chard. Only the young tender leaves are harvested, being careful to avoid injury to the centre bud.

Giant Lucullus is the common variety in general use.

NEW ZEALAND SPINACH

This plant is not a true spinach, although produced by the same cultural methods. The plant is considerably branched, growing 1 to 2 feet high. The leaves are thick, dark green and smaller than those of the true spinach. It thrives in hot weather, the tips of the branches 3 to 4 inches long being cut off and used. The plants are grown 2 to 3 feet apart in the row with the rows about 3 feet apart.

KALE

This plant is a member of the cabbage family, although not forming a head or producing edible flowers. The curled leaves are cooked.

Grown as a fall and early spring crop the seed is sown during August and as early as possible for the spring crop. Rows are spaced 18 to 24 inches apart. When plants are satisfactorily established they are thinned to 6 inches apart in the row.

The cultural treatment is about the same as that for spinach.

PERENNIAL CROPS

ASPARAGUS AND RHUBARB

ASPARAGUS

The underground part of the asparagus plant is comprised of a running underground root stock attached to which are numerous fleshy roots which continue to increase in length for some years. During each growing season new fleshy roots are produced. Numerous small fibrous roots grow each spring on these fleshy roots and die the following autumn. The fleshy roots are for food storage and are able

to absorb food materials from the soil, while the fibrous roots take food from the soil. Attached to the running root stock are buds from which stems with leaves are produced. There are two types of asparagus plants, one having only male or staminate flowers and the other having only female or pistillate flowers. When harvesting of a crop ceases the stems and leaves are produced and these leaves manufacture food which is stored in the fleshy roots and the running root stock for the following spring crop.

SOIL FOR PERMANENT BEDS: Very slightly acid or neutral soil is used for this crop. Any soil should be naturally or artificially well drained. A deep loose soil is necessary to allow the natural root development to be adequate and the roots to penetrate the soil.

Light sandy loam soils and heavy sand loam soils are preferable to light clay loams. However, light clay loam soils are suitable for asparagus provided they allow proper penetration of roots. Soils possessing a hardpan subsoil are unsuitable for asparagus unless the subsoil is loosened for penetration of roots before planting. Soils possessing a gravelly subsoil should not be used.

The soil should be thoroughly prepared as the crop occupies the soil commercially fifteen years and sometimes twenty years if good fertility is conducted. However, fifteen years is the most common. For preparation of the soil for the permanent bed the soil should be well plowed to the depth of eight inches to permit the roots to penetrate the soil as the roots are naturally deep and spreading and must have ample opportunity to penetrate the soil. Disking and harrowing should be conducted after plowing.

CULTIVATION AND CARE OF THE PERMANENT BED: At the end of the cutting season the plant naturally produces stems and leaves which manufacture the food which is stored in the roots to be used for the production of the crop harvested the following early summer. These stems and leaves should be allowed to remain on the plant until dead and the leaves have dropped to the ground. Considering that some rust might be present these stems should be burned in the autumn. Endeavoring to disk these stems into the soil in the spring when only fibre and few minerals remain in them although adding some organic matter to the soil, makes subsequent summer cultivation difficult. Large stems cannot be successfully worked into the soil.

Some weed control and the incorporation of manure and fertilizer into the soil are secured by cultivation.

As soon as soil conditions permit during each spring the bed is disked and harrowed throughout taking every precaution not to injure the buds and crowns. When using the disk harrow examination of buds and crowns of the plants should be made by the operator to make certain that no damage has been done. A shallow harrowing is conducted after the disking. Shallow frequent cultivations with a cultivator are made between the rows previous to, during, and subsequent to the cutting season.

PRODUCTION OF YOUNG PLANTS: The type of asparagus root to plant in the permanent bed is of much economic importance. The best type has four or five large buds above the average size of the lot, spaced apart from each other, and distributed on the crown; while two or more bud clusters should be present on the crown. The large bud is productive of the large spear—the edible leafstalk—throughout the life of the asparagus bed. Also the root to be planted must possess a well developed system of large fleshy roots because a poorly developed root system produces small spears.

The size and yields of asparagus spears are inherited. Hence to grow a large percentage of high producing crowns the seed must carry to the young plants the characteristics of the high producing plants. This seed is secured by mating high producing plants. Asparagus plants are of two types—one possessing only male or staminate flowers and the other type having only female or pistillate flowers. The male flowers are yellowish green and conspicuous, while the female flowers are less conspicuous. The seeds are enclosed in a berry which becomes red at maturity. Bees carry pollen from the male to the female flowers.

To effect the mating of high producing male and high producing female plants the following method is conducted: During spring in the commercial bed permit a few high producing male and a high producing female plant—one male to five or six females is a satisfactory proportion—to produce stems and leaves by cutting no spears. This procedure allows the mating of the staminate and pistillate flowers of high producing plants and effects the production of seed previous to the development of flowers on the low producing plants. The seed secured by mating high producers has very good possibilities of possessing the desirable high producing qualities of its parents. The seed should be harvested when the berries are red; the berries mashed and the pulp washed out in a container of water. The seed is dried by spreading over a screen or cheesecloth, and then stored in a cool place. The size of the seed influences the size of the plant, consequently the larger seed should only be used for the production of young roots.

A few weeks before danger of frost is over the following spring this desirable seed is sown in a sandy loam or light type of soil rich in plant food material. The light type of soil is superior to heavier types because the young roots penetrate the light type with more ease, and because the fleshy roots can be more readily removed from sandy soil than a heavier type. Since the fleshy root system should be well developed and the roots not broken damaging at digging should be maintained at the minimum.

Germination of asparagus seed is decidedly slow, requiring two or more weeks in the soil at usual prevailing outside temperatures. The slow germination at low temperatures is considered to be due to the meagre rate of water absorption. Soaking the seed in water at a temprature of 86 degrees F. for four days has the best effect in hastening germination. Subsequent to the removal from the water, spread the seed on a canvas, stir until the water disappears from the surface of the seed, and then sow at once in moist soil. Of course if one desires to wait for slower germination in the soil he may do so.

Seeds should be sown singly since the grouping of seeds at sowing makes detrimental thinning necessary and causes the intertwining of roots. The separation of the different plants at digging is costly and damages the roots. The depth of sowing is about an inch. The rows should be 24 to 30 to 36 inches apart and the seed in the row 4 to 5 inches apart to provide ample space for the correct development of the young plants which should be 4 to 5 inches apart in the row. This spacing of seed makes thinning unnecessary and may be accomplished by hand, or garden seed drill equipped for spacing seed.

Should a grower unfortunately desire to not space seed at sowing, thinning must be done before the second above-ground shoot appears and previous to the commencement of the development of the fleshy root system. After the fleshy roots have commenced to develop thinning must be conducted by digging out the young plants because the above-ground shoot usually breaks at the crown when the plant is pulled. This digging causes injury to adjacent undug plants.

Frequent cultivations should be conducted during the season of seed sowing effecting thorough weed control. Late during the autumn of the seed sowing season the young roots are dug or plowed up, usually, so that all of the root system remains on the plant. These young plants are placed in a cellar with the tops removed and covered slightly with soil, placing some soil around the roots of each plant. The soil is kept moderately moist; and the temperature in the ventilated cellar quite near 40 degrees F., preventing the roots from drying out. If the cellar is not available the young plants can be placed in soil in a cold frame and the frame filled with straw to prevent alternate freezing and thawing as much as possible.

In the spring before planting they should be sorted to secure only the desirable plants for the permanent bed as already mentioned.

Experimenters have discovered in Massachusetts and California that male plants produce about 25 percent greater yield by weight than the female plants, and that the female plants produce larger spears. In Eastern Canada and United States the plants do not blossom the first year and consequently it would not be possible to select the male plants unless the young plants were two years of age. As one-year-old plants are much preferred to two-year-old plants the selection of only staminate plants would not be possible when planting the desired one-year-old plant. One should also consider that field run plants consist of an average of 50 percent females and 50 percent males.

PLANTING: Planting should be conducted only in the early spring. Subsequent to the thorough preparation of the soil V-shaped furrows should be plowed out. The rows are spaced from four to six feet apart, five feet being a good average. The common method of spacing between the plants in the rows varies from eighteen to twenty-four inches. There is no conclusive experimental evidence concerning these distances but experimenters think that the greater spacing would produce more large spears and perhaps a larger yield.

At planting the fleshy roots are carefully spread out by hand. The centre of the crown is placed on a small mound of earth and the roots rest on the soil. Only two inches of loose soil is placed on top of the buds at planting time. As the young shoots grow up through this soil more soil is added around but not on top of the young shoot. Cultivation of the land accomplishes this method. During the growing season the furrow is filled with soil. Covering the soil the full depth of planting at planting time smothers the buds and young shoots.

The depth of soil over the young plants finally when the furrow is completely filled should be six inches in sand soils and four inches in clay soils.

Weed control and cultivation should be maintained during the season of planting.

Providing some fertility and organic matter in the soil previous to planting of the permanent bed is a good plan.

MARKET PREPARATION: Cutting asparagus is commenced at the beginning of the third season after the plants have enjoyed two full growing seasons in the permanent bed. This practice permits the necessary ample development of roots for food storage. During this first cutting season two to three weeks of cutting is the average cutting, depending on the average size of the spears. Throughout all subsequent harvesting seasons cutting should cease about June 25th to July 1. When at any time during a harvesting season a considerable quantity of spears become small in diameter cutting should cease as the small spears indicate a shortage of plant food in the roots which should not become entirely drained of plant food.

When cutting, the young shoot or spear should be cut an inch below the surface of the soil by inserting a sharp ordinary butcher knife straight down along the side of

the young shoot, and then turning to cut. By keeping the knife close to the spear the buds and spears below the soil surface are not injured.

SALT: Salt is not essential in the growth of asparagus. Experimental evidence goes to show that it has little or no effect, especially when muriate of potash is used.

VARIETIES: *Mary Washington* is a good variety of plant, and is the most generally planted at the present time as it is highly rust resistant.

FERTILITY: Subsequent to harvesting a large amount of healthy vigorous stems and leaves should materialize. These leaves until frozen, manufacture food, and this food is stored in the roots and root stalks. This supply of food is utilized for the production of spears—the edible asparagus—during the following spring and early summer. Consequently we wish the plant food in the soil to be available for the asparagus plant at the end of the cutting season and throughout the remainder of the summer.

During the usual spring disking manure at the rate of 10 tons per acre is incorporated into the soil. This manure adds organic matter as well as nitrogen, phosphorus and potash, and aids in holding water in the soil after it is decayed into the form of humus.

FERTILIZERS: On light sandy loam soils an application of 1000 to 1500 lbs. of 5-10-10 or 6-8-10 in conjunction with manure is recommended. This should be applied broadcast after cutting season has finished. If desired, however, one-half of fertilizer could be applied at the beginning of cutting season and the remainder at its conclusion. On heavier soils phosphorus should be raised and potash decreased.

In addition to the above fertilizer treatment 200 to 300 pounds per acre of nitrate of soda or sulphate of ammonia should be applied during the cutting season. The exact amount depends on the vigour of growth.

Three years' experimental work, 1931 to 1933, 250 to 500 pounds of calcium cyanamid, applied as a source of nitrogen for top-dressing during the cutting season, demonstrated that it is a good source of readily available nitrogen to promote vegetative growth and control most weeds when in their early stages of growth.

RHUBARB

The underground part of this perennial plant is comprised of somewhat woody rootstalks and a fibrous root system. Adjacent to the soil surface is the so-called crown, from which numerous large leaves arise outdoors in the spring. The thick long leaf-stalks of these leaves constitute the edible portion of the rhubarb. Subsequent to the production of the leaves with their edible leaf-stalks is the formation of a flower stalk three to five feet in length.

SOIL AND CULTIVATION: A deep rich sandy soil is best for the growth of this crop but it will thrive on a variety of soils. Plenty of humus and clean cultivation will give a good stand of vigorous plants.

FERTILIZER: When manure is available a top dressing of 10 to 15 tons per acre, applied during the winter would be beneficial. This should be supplemented with 500 to 750 pounds of a 5-10-5 fertilizer per acre. This should be applied broadcast in the early spring and cultivated in the soil. If no manure is available the amount of fertilizer should be increased. However, on heavier soils receiving manure the amount may be reduced.

PLANTING: Commercially, rhubarb seed is not used to propagate young plants of any variety, because the characteristics of the variety are not accurately produced in this manner. Old crowns or plants are dug up and divided to make new plants for commencing new plantings. Each of these new plants must possess one or more good buds, attached to a portion of a root from the old plant. This new plant is placed in a deep furrow with the bud just at or below the soil surface, and well firmed into position. Planting is usually done in spring, but fall planting is often practised. Rows should be four or five feet apart and plants in the row may be two or three feet apart.

All seed or blossom stalks should be removed and no edible leaf stalks pulled for use during the first two seasons.

VARIETIES: Old standard varieties are *Victoria*, a fairly large stalk but often is green in color; *Linnaeus*, a pink coloured but small stalk sometimes called Strawberry; a good variety on account of its tenderness and quality. *Ruby*, a variety introduced by the Central Experimental Farm, Ottawa, of good quality and remarkable colour inside the stalk as well as outside. *Macdonald* is another high quality rhubarb, a very vigorous grower and carries good colour as well. *Sutton's Seedless* is a variety of high quality and large vigorous growth and produces few weed stalks.

HARVESTING: In pulling the stalks a side twist with a light pull will separate the stalk from the crown easily.

PEAS AND BEANS

PEAS

The pea is one of our important canning crops as well as a popular truck crop, where pickers are available to harvest the crop. Peas are usually included in the backyard garden. This is an annual cool season crop, the immature or green seeds being the part of the plant used for food.

SOIL AND CULTIVATION: Peas like a sandy loam soil for the early crop, but any well drained, rich, clay loam will give maximum yields. A cool moist season favours the development of this crop. The seed bed should be well prepared previous to seeding as little or no cultivation can be given afterwards even when planted or sown in rows. A naturally moist soil will give better yields during a dry season, but peas will not thrive in water-soaked soil. Shallow cultivation is conducted until the vines are of sufficient size to cause damage.

SEEDING: Early seeding is practised for the earliest crop and this is followed shortly with additional plantings of other varieties to extend the season. Early seeding favours early development as well as giving the crop the benefit of the cool, early, moist season. For the truck crop the seed is sown in rows thirty inches apart at a depth of two inches. The thickness of sowing varies, usually one to one and one-half inches apart.

VARIETIES:

Thomas Laxton—Good yielder, early, excellent quality; about 3 feet tall. Dark green well filled pods.

Laxton's Progress—About as early as Thomas Laxton; Dwarf, large dark green, good yielding pods, excellent quality; about 22 inches tall.

Laxtonian—About 1½ feet tall; good producer; a few days earlier than Thomas Laxton. Dark green pods.

Telephone—4.5 feet tall. Pods 5 to 6 inches long. Good quality.

Other useful varieties are *Peter Pan*, *American Wonder*, *Little Marvel*, *Lincoln*.

BEANS

Numerous types of beans are produced in Ontario gardens, and the most used specimen is the common bean (*P. vulgaris*). This bean is an annual and possesses a taproot and rows of small roots arising from the base of the stem. The principal root area is between the depths of three to eight inches from the soil surface with some roots about two inches deep.

SOIL AND CULTIVATION: Early snap beans demonstrate a preference for sandy loams, while heavier loamy soils are most suitable for dry beans and string beans. A fairly rich soil is desirable, yet a comparatively poor soil is satisfactory and a very rich soil produces an excessive vine growth. Good drainage and a neutral to alkaline soil reaction are necessary. Shallow cultivation is practised but never in wet vines, as an assistance to the control of disease.

The seed is sown 4 to 6 inches apart in rows 2 to 3 feet apart, about 1½ to 2 inches deep on heavy soils and 2 to 3 inches on lighter soils after danger of frost is over, as they are frost tender.

VARIETIES:

Dwarf Butter or Dwarf Wax—

Early Stringless Wax—Yellow pods, 5¾ inches long, an excellent market variety, brittle, tender.

Davis White Wax—A good market garden variety and first class shipper. About 3 to 5 days earlier than Pencil Pod Black Wax, not of the best quality; yellow pods straight 5 to 6½ inches long. White beans may be used for baking.

Pencil Pod Black Wax—Black seeds, pods light to dull yellow, excellent quality, fine texture, stringless, round, broad oval to nearly circular in cross section, about 6 inches long. Commencing to harvest in 50 to 55 days, grown extensively by home and market gardeners.

Golden Wax—Oval yellow pods, 4½ to 5 inches long, a good home garden bean, pods somewhat short for market, good quality. Same season as Pencil Pod Black Wax.

Webber Wax—Pods 5 to 6 inches long, light waxy yellow, good quality, stringless, flat and straight. Commence to pick in about 50 days.

Dwarf Green Podded—

Bountiful—Earliest and best quality of stringless flat podded varieties; pods 6 to 7 inches long, remain in good condition for long time after picking; picking commences in 50 days.

Full Measure—Round podded, excellent quality, stringless, brittle; about 3 days later than Bountiful. Very satisfactory for home and market gardens.

Tendergreen—Round podded, same season as Bountiful, stringless, excellent quality, brittle, fleshy, a good market variety; pods 4½ to 6½ inches long.

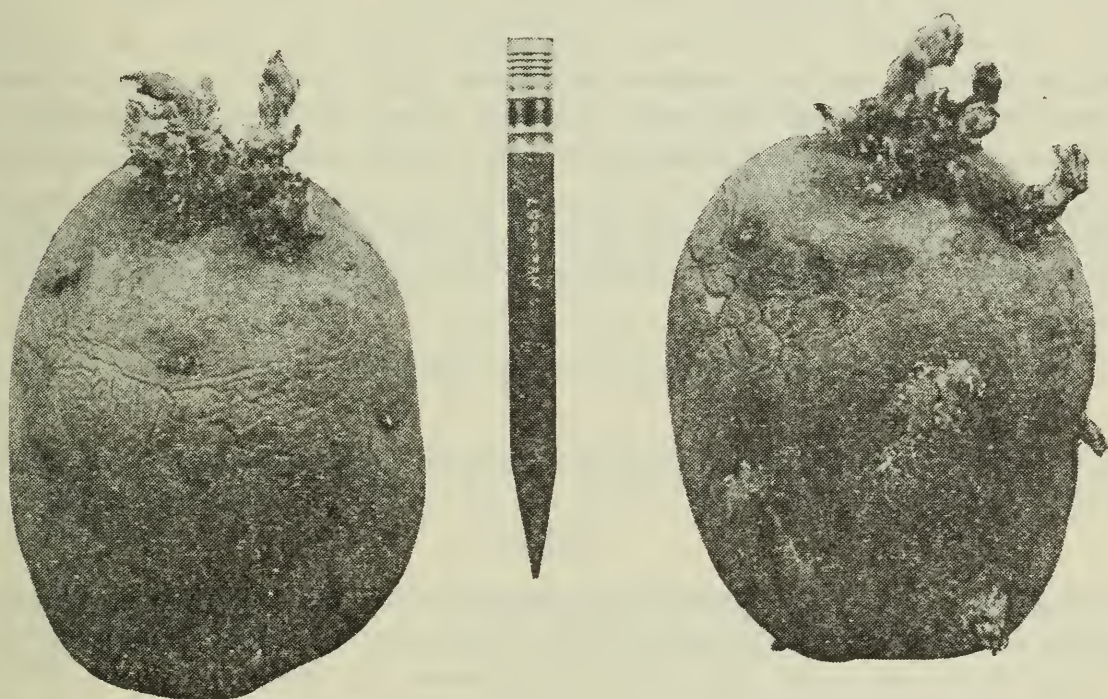
Broad Windsor, the English broad bean, sown as early as soil conditions permit.

Pole Beans—*Kentucky Wonder*.

FERTILIZERS FOR PEAS AND BEANS: These vegetables grown in the market garden which is usually on light sandy loam soils, will respond to any good fertilizer of the following proportions: 3-10-6, 2-12-10 or 4-8-10. Applications of 250 to 500 lbs. per acre, applied broadcast and worked into the soil previous to sowing are advised.

EARLY POTATOES

SOIL: A good well-drained loam soil, rich in humus and plant food, will grow a good crop of potatoes. The lighter soils suit better for earliness. Preparation of the soil before planting should be given special attention. Provide as deep a bed of mellow soil as possible and avoid fresh manure.



Potato Seed sprouted in the light and illustrating the proper stage for planting

SPROUTING POTATOES FOR SEED: This practice is conducted by exposing the potatoes, some two weeks before planting time, to the light. The potatoes are spread out along the floor or in flats or shallow boxes in a greenhouse or a well-lighted barn or room where they will not freeze. Young sprouts soon develop and these grow thick and become firmly attached to the tuber. In length they should not be more than about half an inch. With careful handling and hand planting these sprouts may be planted intact with the sets and should produce a crop ten days to two weeks earlier than the unsprouted sets. Where cut seed is to be held over, the best material to treat it with is land plaster or gypsum. It is best, however, to plant potato seed as soon after cutting as possible. Treating with lime may tend to encourage scab development.

Planting: Potatoes are cut into pieces of nearly two ounce size. Sometimes small sized tubers are placed without cutting to good advantage to prevent rotting, in the event of unfavourable weather. The usual distance of planting is from twelve to fifteen inches in the row with rows thirty inches apart. The best depth is from 3 to 4 inches.

Cultivation may be deep and thorough at first but later should be shallow and only sufficient to control weeds and to give the necessary ridging or hilling to protect the tubers.

Harvesting begins with the early crop, often before it is mature. As the potato is a cool season crop, best development and tuber formation takes place mainly during the late summer months. The early crop develops previous to the extreme heat of mid-summer. A digging fork is used for small plots but a plow or regular potato digger is used for large areas. The tubers should be carefully handled to avoid bruising.

VARIETIES: Commercial varieties used for early potatoes at the time of writing this bulletin are: *Irish Cobbler*, *Warba*, *Gold Nugget* and *Early Ohio*.

FERTILIZER:: Potatoes respond well to soil fertility treatments, provided, of course, the fertilizer is suitable and correctly applied. In practice, applications range from 500 to 1500 lbs. per acre. Applications up to 1500 lbs. per acre should be applied in bands 2 inches from each side and either on the same level or slightly below the seed piece. For heavier applications than the above, the additional fertilizer should be applied broadcast and worked into the soil previous to planting. On sandy loam soils well manured, a 4-8-10 mixture will be very suitable. On heavier soils a 3-10-6 or 2-12-6 fertilizer will give better results. On well decomposed muck soils a 2-8-16 or 2-8-24 will give satisfactory results. Potatoes do best on a slightly acid soil which will tend to prevent the development of the scab organism. If the soils are too alkaline in reaction fertilizers leaving an acid reaction are recommended.

ROOT CROPS

BEET, CARROT, PARSNIP, RADISH, SALSIFY, TURNIP

BEETS

The beet is a biennial, producing a thickened root and leaves the first year and seed the second year. The commonly known beet seed is a fruit, containing two to six seeds which may retain their germinating power for about five years. The root system is comprised of a taproot from which small branches develop. Numerous roots are produced from the bottom of the beet, while near the soil surface many roots extend horizontally through the soil. The small lateral roots have many smaller branch roots. Much of the lateral root development exists in the surface three to four inches of soil.

SEED SOWING AND PLANTING: For the early outdoor sown crop seed is sown in the garden with the garden seed drill at the conclusion of severe frosts, at the rate of four to six pounds per acre in rows fourteen to eighteen inches apart to a depth of three-quarters to one and one-quarter inches, varying with types and conditions of soil.

To obtain marketable beets about ten days to two weeks earlier than the early outdoor sown crop seed is sown in the soil in flats or on benches about March 1st. The seedlings are transplanted to other soil in flats, spacing one and one-half inches apart each way. When the soil in the field is suitable for preparation and hardening-off has been conducted, transplanting to the field in rows fifteen to eighteen inches apart and four inches apart in the rows is conducted.

The late crop for winter storage is sown during July, as late as the second week in some communities.

Thinning is necessary for the seed sown field crop because more than one seed is in each fruit, and hence the young plants grow in clumps. All plants except one in

each clump should be removed, spacing about two to three inches. When the sufficiently sized beets are harvested the small ones, spaced about three to four inches apart in the row, are left to secure suitable size.

VARIETIES: For the early crop *Early Egyptian* and *Crosby's Egyptian* also called *Early Wonder*. For the main crop—*Detroit Dark Red*.

MARKET PREPARATION: The early bunching beets with fresh tops and cleanly washed, are suitable for market when one and one-half to two inches in diameter. For autumn use and winter storage the beets are harvested previous to frost. The beets should be placed in small piles in the field and covered with their tops for a few days to permit sweating and drying previous to storing.

CARROTS

The carrot is a biennial. The first season a thickened root and a large well branched system numerous fine roots, well distributed through the soil; and leaves comprise the plant. The second year stems, flowers and seed are produced.

SEED SOWING: Seed for the early outdoor sown crop is sown after severe frosts have concluded at the rate of about two and one-half pounds per acre in rows varying from twelve to eighteen inches apart to a depth of one-half inch. For the late storage crop seed sowing is done at the middle or latter part of June. For home use a succession of sowings may be conducted as late as the middle of July. Weed control is very important.

VARIETIES: *Chantenay*—A satisfactory bunching carrot for early or late crops in the home or commercial garden. Stump end is buntly rounded; colour, orange-red, with a lighter colour towards the core.

Coreless or Nantes—Used for home and market gardens, possessing a very small core; colour, orange with yellow at the core; shape, cylindrical with a blunt rounded stump end.

Danvers—Satisfactory for market garden and home use. Core very distinct; colour, orange, yellowing at the core, distinctly tapering from shoulder to stump end which is pointed.

Guerande or Oxheart—Used slightly. Having a medium to large core, colour, orange; short and blunt ended.

MARKET PREPARATION: Bunched carrots are pulled when the top ends have attained a diameter of one-half to three-quarter inches. A part or the entire amount of leaves is allowed to remain on the carrots which, when perfectly clean by washing, are tied in bunches of uniformly sized eight or twelve specimens. For the late storage crops they are usually hand-pulled after partly plowing out and topped with a knife.

PARSNIP

The parsnip is one of our root crops grown as an annual, but is biennial in habit of growth. The roots are hardy and will live over winter in the soil. Considerable quantities of parsnips are used during the winter months but this is not as profitable a crop as most of our root crops.

SEEDING: Parsnip seed is sown at a depth of one-half to three-quarters inches in spring as early as the soil can be prepared and rows are made to accommodate either

hand or horse cultivation; and the young plants are thinned from two to five inches apart. Cultivation should be very shallow at first and only enough to keep down weed growth. A rich deep soil is necessary because a shallow soil causes crooked and branched roots.

PREPARATION FOR MARKET: The roots may be dug in the fall as needed. Most or all may be taken up just before winter and stored in cool cellars or pits, where they are available for marketing over the winter months. Roots dug in early spring are fresh and usually better than stored roots. For market the roots are trimmed and washed and packed in baskets or bags as desired. Parsnips left in soil over winter quickly lose their quality when warm weather comes and the tops start into growth. There is no evidence that the roots become poisonous during this stage.

VARIETIES: *Improved Hollow Crown* is the most common variety.

RADISH

This crop is one of our easiest and quickest crops to reach maturity requiring a sandy loam soil, moisture and warmth enough to encourage rapid growth. Earliest crops are grown in frames and in protected outdoor lots.

SEEDING: Seed is sown thinly in shallow drills in well prepared soil making the rows about 16 to 18 inches apart. No thinning is done except when first ones are ready to pull, the larger ones are taken first making about three pullings. Successive plantings will give a continuous supply of radishes. Seed of the summer radish is sown medium early and develops to best stage during the early summer. Both the winter and summer radishes are much larger than the ordinary or spring radish. Seed of winter radish may be sown about the first week of July for best results. These are thinned and make most growth late in the season and are harvested in fall and may be stored.

VARIETIES: *Scarlet Globe, Early Scarlet Turnip White Tip, Glowing Ball, Saxa, French Breakfast.* *Winter Varieties: China Rose.*

TURNIP

There are two forms of this crop—the summer or white turnip and the winter or rutabaga.

CLIMATE: A moderate temperature during the day with cooler nights, together with plenty of moisture tends to produce the highest quality.

SEED SOWING: Seed is sown in drills for home garden culture about one and one-half feet apart, and for field culture the distance apart is increased to permit horse cultivation. Many growers practise sowing the late or rutabaga turnips on top of low ridges or drills, affording easier hand cultivation and an advantage during a wet season.

THINNING: The plants are thinned early to stand six inches or more apart.

HARVESTING: The crop is harvested mainly by hand pulling and trimming both tops and long roots, leaving a smooth nearly round root. Turnips are sold under grade for size and quality.

VARIETIES: *Garden—White Milan, Purple Top Milan and Golden Ball* are all suited for home and truck gardens. The *Swede or Rutabaga type* are *Purple Top Swede* and *Canadian Gem*.

SOIL AND CULTIVATION FOR ROOT CROPS

A moderately deep, moist, well-drained, easily crumbled soil with plenty of organic matter (slightly acid in reaction) is best to allow unhindered expansion of the carrot during growth. Early commercial crops are grown principally on sandy loams, while for the winter crop, requiring large yields, a silt loam is very satisfactory. Late carrots may be grown well on muck soil. Heavy compact soils usually produce misshapen carrots, checking their symmetrical development. The soil for seed sowing should be smooth, loose and well prepared. Quite shallow cultivation is desirable.

FERTILIZERS FOR ROOT CROPS

On light sandy loam soils apply from 15 to 20 tons of well rotted manure the previous fall. From 750 to 1000 lbs. of 5-10-10 or 4-8-10 fertilizer mixture applied broadcast and worked into the soil before planting is recommended. If no manure is available, the rate of application should be increased.

On well decomposed muck soils the same rate of application of 2-8-16 or 2-8-24 would be suitable when applied in a similar manner. If possible it would be advisable to apply a portion of the fertilizer in the row beneath the seed when planting. If the soil is lacking in available nitrogen due to cold weather side dressing with 100 to 150 pounds per acre of nitrate of soda or sulphate of ammonia is advised. •

SALAD CROPS

CELERY, LETTUCE, PARSLEY, CRESS, ENDIVE

CELERY

Celery is a biennial. Throughout the first year a comparatively short stem is grown, and during the second year stems two to three feet high produce flowers and seeds. With certain growth conditions the plant produces flowers and seeds during the first year, described as "Premature Seeding." If not transplanted the plant has a taproot with side roots. Transplanting in the production of the young plants destroys the taproot, and in its place numerous lateral roots, well covered with fine roots throughout their length appear. The greatest amount of root system is in the surface six inches of soil with numerous roots at from two to three inches from the soil surface—a few extending to a two foot depth. A large part of the root system is within a radius of six to eight inches from the plant—the longest radius being twelve inches.

EARLY CROP

SOIL AND CULIVATION: The most satisfactory quality celery is produced by providing conditions of fertility and water supply for continuous growth. A well-drained sandy loam soil, well supplied with organic matter and watered by irrigation, is correct for the early crop. The requisite continuous growth occurs most satisfactorily on well-drained muck land, naturally possessing plenty of organic matter, strong water-holding power, and a good physical condition. Muck soil is used for the early crop; but for this early crop heavier soils than sand or muck should not be used.

The soil should be prepared by deep plowing during the autumn previous to the early crop. Throughout the spring until planting frequent harrowing is done to

control weeds. The necessary fine state of cultivating of the soil for planting is obtained by thorough disking and harrowing and rolling or dragging.

Shallow cultivation is always desirable particularly near the plants due to the close position of the roots to the surface of the soil. Thorough weed control should always be maintained. Immediately after planting and frequently afterwards, shallow cultivation is performed to maintain a soil mulch, but the soil must not be placed into the heart. Cultivation ceases at blanching time.

PRODUCTION OF YOUNG PLANTS: Celery seed is not sown on the site of the field where the crop is to grow to maturity. The very slowly germinating seeds are quite small; and the young plants are quite tender. The particular attention, necessarily provided to produce young plant, cannot be given in the field where the plant is to grow.

Sowing seed for the early crop is conducted about the middle of February. The soil for seed sowing should have plenty of plant food, be well pulverized, and should not pack nor harden. A good sand loam compost soil or a field muck soil in the greenhouse or hotbed is used. One should always purchase the best quality of seed.

The seed is sown in rows two inches apart in this soil in a flat to a depth of about one-sixteenth of an inch, and covered with fine sand. Sowing in rows facilitates watering and weeding compared to broadcasting. A very fine spray of water is used in a thorough watering immediately after sowing. Germination proceeds slowly.

At once after sowing the flats are placed in a temperature of 70 to 75 degrees F. After the young plants come through the soil they are kept in a temperature of 65 to 70 degrees F. until field planting. Transplanting of the seedlings to another flat, containing the same kind of soil as that used for seed sowing, at about one and one-half inches apart each way is conducted when the seedling possesses three true leaves. This transplanting accomplishes the breaking off of the taproot which produces the desirable lateral fibrous roots.

Every attention to watering is required after seed sowing and throughout the growth of the young plants, not allowing the soil to dry out, and yet not permitting a soaked condition of the soil.

PREMATURE SEEDING OF CELERY: This term is applied to the development of flowers and seeds during the first year in the field, and thereby preventing its proper maturity for marketing.

In Cornell University, Ithaca, N.Y., Bulletin No. 480, published May, 1929, Dr. H. C. Thompson, Professor of Vegetable Crops, discusses six years' experiments with this problem.

During the three year test placing the young plants before field setting in temperatures averaging between 45 to 50 degrees F. for thirty days always resulted in the development of a large percentage of seed stalks. Producing the plants for from fifteen to twenty days in temperatures of from 45 to 50 degrees F. resulted in from 11.65 percent to 47.33 percent to 65.80 percent premature seed development each year. In a temperature of 45 to 50 degrees F. for ten days, 8 percent of the plants went to seed. Not a single plant, which was always grown in an average temperature of 62.7 degrees F., 65.2 degrees F. and 71 degrees F. until field planting went to seed in the field. All of these plants were produced under the same growing conditions in the greenhouse and field except for the ten to thirty days in the coldframe. Having the plants in temperatures averaging from 40 degrees F. to 50 degrees F. for from ten to thirty days results in premature seeding, in spite of the fact that the plants are afterwards grown in favourable growth conditions.

Additional experiments conducted entirely in the greenhouse indicate that celery plants produced for two to three months in temperatures averaging between 50 degrees F. to 55 degrees F. go to seed the first year.

This information distinctly demonstrates the danger of growing celery plants for two or three months in a cool greenhouse or hotbed and then placing them in a coldframe for ten days or two weeks in a low temperature of 40 degrees F. to 50 degrees F. "Hardening-off" celery plants in the coldframe is dangerous in regard to premature seeding and is not necessary.



Celery in Thedford District

PLANTING: Just previous to planting the soil containing the young plants should be watered thoroughly to have as much soil as possible attached to the roots at field planting time. The growing point or heart must not be covered with soil and yet the roots must be well and firmly surrounded with soil. Holes in the soil for the plant are made with a pointed wooden dibble.

Celery is planted six to eight inches apart in the row with rows two and one-half to four feet apart. Sometimes for a close method the rows are eighteen inches apart. Usually three plants wide zig-zagged about eight inches apart are planted in each row. A solid bed, six to ten feet wide, with plants eight inches by eight inches, is also used so that the plants exclude the light for blanching except the outside rows which are blanched with boards.

BLANCHING: Blanching is attained by excluding the light from the leaf stalks during the growing of the plants to secure the desirable white colour and flavor. For the early crop only paper or boards are used. Soil is unsafe to use for this purpose with the early crop as this arrangement in hot weather is likely to cause rot. A specially prepared paper for celery is satisfactorily used and is held adjacent to the plants by wire hooks. Twelve inch width boards are also staked up beside the plants instead of the paper.

MARKET PREPARATION: The early celery is usually washed and the roots carefully trimmed off and tied in bunches and shipped in clean boxes.

LATE CROP

SOIL AND CULTIVATION: Any rich but well-drained loam soil produces satisfactory celery if the moisture supply is adequate. Heavy clay is not necessary. The necessary continuous growth to produce good celery is better attained on muck soil than on other soils due to the organic matter in the muck soil, making a better physical condition and a strong water-holding power. The well-drained muck soil is most largely used for the late crop.

Cultivation is the same as that for the early crop.

PRODUCTION OF YOUNG PLANTS: The plants for the late crop are grown in hotbeds in good sand compost soil or field muck soil containing plenty of fertility. The seed is sown during the last two weeks in April in rows about three inches apart; and the young plants, thinned to about one inch apart in the row. The young plants are taken directly from the hotbed to the field for planting.

Some growers sow the seed in flats in hotbeds in rows two inches apart and then transplant to the soil in coldframes at the development of the first three true leaves.

PLANTING: Distances of planting are similar to those of the early crop.

BLANCHING: Blanching is attained by boards, paper or soil.

FERTILIZERS FOR CELERY: Celery is a heavy feeder on nitrogen and potash, hence large quantities of these plantfoods in readily available form should be applied. When planted in rows 2½ feet by 8 inches on light loams, from 1000 to 1500 lbs. of either a 4-8-10 or 5-10-10 may be used. If little manure is available the amount of fertilizer applied should be considerably increased.

During the early growing season, side dress the young growing plants with 200 to 300 pounds per acre of nitrate of soda or sulphate of ammonia. This treatment should be repeated in 2 to 3 weeks, especially if the season is cold and wet.

On muck soils, from 1500 to 2000 lbs. of 2-8-16 or 2-8-24 has given good results with side dressings of available nitrogen as recommended above.

When celery is planted in block (8 inches square) approximately twice the above recommended amount of plant food should be applied. Parts of the application should be broadcast and well disced in previous to planting and part applied beneath the rows at planting time. In close culture methods the full application should be applied broadcast and well disced in previous to planting.

VARIETIES: "*Paris Golden Self-Blanching*", also called "*Paris Golden Yellow*". With foliage of yellowish-green. The heart is large. The stalks are crisp, of medium height, and blanch to a creamy-white. This is an early and late variety.

The old strain of this variety produces short, thick stalks and a well developed heart. The tall strain grows more vigorously and is taller and more spready than the old strain.

"*Golden Plume*", also called "*Wonderful*" and "*Early Fortune*", is similar in colour and flavour to "*Paris Golden Self-Blanching*", and is about one week earlier than that variety. The "*Golden Plume*" is more erect, vigorous, and produces a better heart than the dwarf strain of the "*Golden Self-Blanching*". "*Golden Plume*" is an early or late variety.

"*Giant Pascal*" is a late variety, much used for autumn and winter purposes. The green leaf stalks are thick and blanch slowly to a creamy-white colour. The quality is very fine.

"Fordhook Emperor" possesses a spreading habit of growth with very short leaf stalks which blanch to a nearly white colour. It is a winter variety.

"Utah" is a green stalked variety of vigorous growth, heavy heart, thick leaf stalks and an excellent table quality. Suitable for winter storage.

"Golden Phenomenal", similar to *"Golden Plume"*, used as an early variety, frequently.

MARKET PREPARATION: Celery is now shipped in standard sized celery crates. The roots may or may not be removed from the plant at harvesting or crating, and usually no washing is conducted. Every attention should be paid to preparing a firm high quality product and particularly when cold storage is to be conducted.

LETTUCE

The lettuce plant is an annual and will grow to seed maturity in one season; but its leaf is used as a salad, and the quality, tenderness and flavour depends on growth conditions. The roots of the lettuce plant are fibrous and small, so require special preparation of the soil before seeding or planting. It is a cool season crop, growing best during the spring and fall months. It requires moist soil, and will not develop properly during the hot dry summer days unless given special attention as to irrigation and possibly shading.

SOIL AND CULTIVATION: Any rich, moist soil, slightly acid to neutral in reaction, will produce a good crop of lettuce, but for extensive plantings a sandy loam (for earliness) a silt or clay loam, or a rich muck soil is best. The soil should be fertile, contain a high percentage of humus, and be well drained. If the soil has been well prepared little cultivation is required during the growth of the crop. Cultivation should be shallow and just sufficient to control weeds.

SEED SOWING: Seed sowing is conducted about eight weeks previous to planting the young plants in the permanent position for the crop's production. The seed is sown in compost soil in flats or hotbeds, broadcast or in rows two inches apart, and just slightly covered with coarse sand or compost soil. Thorough watering of the soil immediately after sowing is important.

At completion of sowing an air temperature of 60 to 70 degrees F. is provided until the young seedlings have just appeared through the soil surface. At this appearance and until two seedling leaves are developed, 60 degrees F. is maintained. After this stage of leaf development throughout the life of a young plant an air temperature of 55 to 60 degrees F. is afforded to produce a strong, healthy, moderately slow growth. Higher temperatures of air than 60 degrees F. usually produce a somewhat spindly plant.

When the first true leaf is partly developed these young plants are transplanted to a compost soil in flats or hotbeds about $2\frac{1}{2}$ by $2\frac{1}{2}$ inches apart. The soil should be carefully firmed around the roots and well watered to enable them to secure moisture and plant food materials.

Subsequent watering of the soil containing these transplanted plants should be conducted with much care. Too much water and heat force the plant to grow tall with a weak stem. The soil should not be allowed to dry out but maintained in a moderately moist condition. The young plants must be hardened off for about ten days before field planting. Young plants for the early leaf and early head lettuce crops are produced in this manner.

LATE CROP LEAF AND HEAD LETTUCE

Later crops are sown in the field by a hand-drill with rows from 15 to 18 inches apart. The young seedlings of the leaf lettuce are thinned to stand 8 inches apart in the row, while the head lettuce is spaced 12 inches apart in the row. The same space is provided for transplanted plants. Leaf lettuce is produced in hotbeds and coldframes in the spring to a large extent. Head lettuce seed is sown the middle of July for late September harvesting.

VARIETIES: *Leaf Lettuce*—*Grand Rapids* has decidedly crumpled leaves with much frilled borders and is the most largely grown variety of this type.

Head Lettuce—*New York*. The head is firm and round. The leaves are dark green in colour and tightly over-lapping one another. The broad leaves have fine frilled borders, are crumpled and heavily veined. It is the most largely grown variety. Buyers and shippers mention "Iceberg" in referring to this variety.

Hanson—(*Non-pareil*). It is similar to New York but the leaves are a much lighter green in colour.

Iceberg is quite similar to New York. However, the edges of the leaves are reddish-brown in colour. It is little grown.

Butterhead Lettuce—*May King* is an early smooth leaf cabbage heading type with a golden buttery colour with a rich flavour.

FERTILIZERS: On light sandy loam soil receiving from 15 to 20 tons of well rotted manure in the previous autumn, applications of 1000 to 1500 lbs. of 5-10-5 or 4-8-4 mixture will be very suitable. If little manure is available, the same rate of 5-8-7 or 6-8-10 would be more suitable. If the soil is low in available nitrates due to lack of organic matter or a cold wet season side dressing of 150 to 200 pounds per acre of nitrate of soda or sulphate of ammonia is highly advisable.

On muck soils, mixtures higher in potash must be used and a 2-8-16 or 2-8-24 at 1000 to 1500 lbs. per acre with top dressings of additional nitrogen if growth is backward would be very suitable.

MARKET PREPARATION: The lettuce heads are trimmed closely to remove very loose leaves and stem when a well formed, preferably solid head, is produced. For local markets the heads are placed loosely in hampers and sold by the dozen. For shipping the heads are packed in a crate, lined with heavy waterproof paper, which is situated on the total interior surface of the crate, and fastened around the lettuce tightly after packing at the top. Layers of heads are tightly packed in the crate with stems up to prevent water from melting ice entering the head. Cracked ice is usually placed between the layers of the product. If shipped in ice refrigerator cars the cars should be thoroughly cooled previous to loading, re-iced to full capacity in transit to destination, and about a foot of ice placed on top of crates in car at loading.

PARSLEY

It is easily grown from seed and the young leaf stems are the parts used for garnishing and flavouring. As the plants grow older seed stalks are sent up and a crop of seed is formed.

SEEDING AND CULTURE: Parsley seed germinates slowly. For the first crops seed may be sown in house and the young plants set out early as they are quite hardy. Seed may be sown in the open and the young plants thinned out to stand four to eight

inches in the row. This is a cool season crop and the best yields are obtained off young vigorous growing plants. Well grown young plants are put into a cool greenhouse for winter production. The season for fresh parsley may be extended well over the winter by this means.

PREPARATION FOR MARKET: Only a few of leaf stems are taken from a plant at a time. The leaves are tied in small bunches and washed and sent to market.

VARIETIES: *Moss Curled* and *Paramount*.

CRESS

Garden Cress is a cool season annual crop grown for its leaves. Seed is sown in rows 12 to 15 inches apart as early as possible in the spring, in cool, rich soil. If the crown is not injured at the leaf removal the plant continues to produce leaves.

ENDIVE

This is a cold season crop grown for its leaves. Seeding for the early crop is done as early as soil conditions permit in the spring, and for the late crop the middle of July. Soil, planting distances and cultural treatment are the same as those for lettuce.

For salad use the leaves are blanched to minimize bitterness and afford tenderness. Blanching is secured by excluding sunlight from the central leaves, by tying the leaves of each plant into a bunch at the top or covering plants with straw.

SWEET CORN

Sweet corn is an annual, and if offered on the market quickly after harvesting to prevent deterioration of flavour and quality.

SOIL AND CULTIVATION: Early corn is requisite for profit for market gardening. Therefore, a well-drained sandy loam soil, possessing plenty of decayed organic matter and fertilizer, is demanded for this early crop.

The soil should be fall plowed and then disked and harrowed in the spring to effect thorough preparation.

PLANTING: Frost injures sweet corn, and planting should be conducted after frost danger is over unless one desires to take chances to secure high prices for the early market. If hills are used six seeds per hill are sown and allowed to grow. The hills are spaced 2 ft. by 2½ ft. or 2 ft. by 3 ft. apart for the small growing variety; and 2½ ft. by 3 ft., 3 ft. by 3 ft. or 3½ ft. by 3½ ft. for the large growing varieties. When drilled the seeds are planted singly and the plants are thinned to grow 10 to 15 inches apart, depending on the size of the variety. Planting can be performed by hand but usually by the hand planter. Machine planters are used with large acreages.

Suckering is the removal of suckers from the base of the plant. Experiments conducted for five years in New York State with Golden Bantam and Stowell's Evergreen by Dr. H. C. Thompson indicate that the removal of suckers tends to decrease the yield and does not appreciably hasten maturity or increase the size of the ears. The leaves of the suckers aid in the manufacture of food for the plant.

VARIETIES: *Early—Golden Gem* is the earliest yellow variety, home and early market use. Ears are often as large as the Golden Bantam or plants are not as productive as the Golden Bantam. Rows 8-12. The husked ear in size 6-7 by 1⅜-1⅝ inches. Good quality.

Golden Sunshine secures edible yellow ears in about 72 to 75 days. Good quality. About a week earlier than *Golden Bantam*; 10 - 12 rows; somewhat lighter yellow than *Golden Bantam*. Husked ear 7 - 2 by $1\frac{3}{4}$ to 2 inches; moderately plump.

Golden Bantam, a yellow variety; while not as early as the *Golden Gem* and *Golden Sunshine*, is of superior quality to either of them. Husked ear 6 - 7 by $1\frac{1}{2}$ to $1\frac{5}{8}$ inches; 8 rowed. There is also the 10 row *Golden Bantam*.

Late—Stowell's Evergreen; white.

FERTILIZERS: Corn responds well to applications of farmyard manure which should be well rotted and applied in the autumn at rates of 15 to 20 tons per acre. On light soils, 250 to 300 lbs. per acre of an 0-12-10 or 2-12-10 fertilizer is recommended. On heavier soils on 0-12-6, 2-12-6 or 3-10-5 will be more suitable. Where the soil is low in organic matter and available nitrogen, fertilizers having a higher percentage of nitrogen or side dressings of available nitrogen is recommended. The most advanced method of application is in bands on each side of the hill 2 inches from the seed and on the same level or slightly below.

EGGPLANT — PEPPERS — TOMATOES

EGGPLANT

The eggplant is an annual plant distinctly sensitive to frost and is grown in the Province only where long seasons occur.

SOIL AND CULTIVATION: Well-drained, warm well-manured soil is usually used for this crop. Cultivation is the same as that for the tomato.

PRODUCTION OF YOUNG PLANTS: Seed sowing indoors is necessary during the last two weeks of February, and the seedlings are produced as are those of the early tomato crop. The transplanting is conducted when the rough leaves occur into four inch where they are grown until field setting. No check in growth must be allowed.

FIELD PLANTING: When the warm weather is prevalent and frost danger concluded planting is conducted, using distances of 30 to 40 inches between the rows and 24 to 30 inches between the plants in the row.

VARIETIES: *Black Beauty*.

PREPARATION FOR MARKET: The fruit should be well coloured and is cut from the plant to have the calyx and a small part of the stem attached to the fruit. The fruit is picked when about half grown or slightly later as it is used in an immature condition. If allowed to remain on the plant until fully ripened the flesh usually becomes dry and tough.

PEPPERS

The fruit is used mostly in the green stage but ripe or red fruits are in good demand. The sweet large type is most popular but the hot or pungent varieties are grown to a considerable extent. The season extends from mid-summer to late fall and sound fruits can be held for a time in storage. The pepper is a warm season plant and requires an early start and a long growing season to be successful. The plants are handled much the same as tomato plants. Peppers do best on a warm early rich soil and should never be planted on heavy wet soil.

SEEDING AND PLANTING: Pepper seed should be started early some time in March. Usually the seed is sown just previous to early tomato seed. The seedlings are transplanted once or twice and grown similarly to tomatoes until planting time, which will be about June 1st. The plants should be well developed and may have some fruits set. The plants are spaced eighteen inches in rows and rows may be two to three feet apart.

VARIETIES: *Sweet or Mild—California Wonder*, produces medium early. Large size, thick flesh, heavy yielder, fine quality.

Harris Earliest—The earliest sweet pepper; a heavy cropper and medium size.

Harris Early Giant. Slightly later and much larger than Harris Earliest. Good quality.

King of the North—produced by Harris. Large, medium thick flesh, early, good yielder.

World Beater—About the same season as California Wonder; thick flesh, a large fine quality pepper.

Hot—Hamilton Market.

Hungarian Wax—Quite hot, early, 5 to 6 inches long, good quality.

FERTILIZERS FOR EGGPLANT AND PEPPERS: Peppers are similar to tomatoes in their soil and fertilizer requirements. When grown on well manured sandy loam soils, application of 750 to 1000 lbs. of 3-10-5 or 4-12-6 will give good results. If the soil is low in organic matter and little manure is available, the amount of nitrogen and potash should be increased and a 4-8-10 or 5-10-10 would give good results.

EARLY TOMATOES

Seed is sown from about February 25th to March 1st in rows two and one-half inches apart or broadcast about one-eighth of an inch deep in preferably sand compost soil, situated in flats, raised benches or in a hotbed. Germination air temperature is from 70 to 75 degrees F. The flat is a wooden box, 24 by 12 by 3 inches deep with six small holes in bottom for drainage.

When the seedlings have developed a small amount of the first true leaf and a well sized root system the first transplanting is conducted. The plants are transplanted into preferably sand compost soil into flats, fifty-five to sixty plants per flat, or into the compost soil in greenhouse raised benches or hotbeds without the flats. At this transplanting cover the plants with newspapers from the sun during the first day after planting. Water soil thoroughly after transplanting.

The second transplanting is conducted when the leaves of adjacent plants in the flats commence to touch each other and a moderately sized root system is present. At this transplanting the plants are planted into compost soil in 3½ to 4 inch pots, or about eighteen to twenty-four plants per flat, or in compost soil in raised benches or hotbeds. The individual container is often preferred, but not positively necessary. The individual container preserves all of the roots at field planting time.

During day and night from the time the young seedling plant appears through the soil and until the commencement of hardening-off, the air temperature is 60 to 70 degrees F.

The early young tomato plant should not be severely hardened-off. For about ten days to two weeks' time immediately previous to field planting, hardening-off is

conducted by somewhat decreasing the moisture in the soil gradually, providing plenty of ventilation and possibly an air temperature at night of 55 degrees F., but not lower.

Ventilation should be maintained consistent with outside weather conditions and temperatures to prevent condensation of moisture on the leaves of the young plants — the older the plants, the more ventilation.

These young plants for this early crop are produced as just discussed for either the staked tomato or without staking.

The field soil for this staked or unstaked crop should be well drained sand loam soil, well supplied with organic matter from farmyard manure or green manuring crops. The fairly well decayed manure may be applied in the autumn previous to the tomato crop, but is best added to the field soil just before some vegetable crop which precedes the early tomato crop to permit of thorough decay and incorporation into the field soil. Preparation of soil must be very thorough.

FERTILIZERS: Tomatoes are sensitive to unbalance soil fertility conditions and excesses or deficiencies of any one plant nutrient will seriously impair the yield or quality of fruit.

On light sandy loams which have been well manured or a heavy crop of legumes plowed under, an 0-12-10 or 2-12-10 fertilizer applied at the rate of 750 to 1000 lbs. per acre is recommended. On medium and heavy sand loams receiving the same cultural treatment, the same rate of application of either an 0-12-6 or 2-12-6 mixture will be more suitable. If manure is scarce or the soil is known to be low in available nitrogen, 3-4 percent. nitrogen in the fertilizer mixture could be used to advantage and the rate of application increased to 1000-1200 lbs. per acre. If, however, this is inconvenient, the additional available nitrogen could be applied as side dressings during the early growing season, at 150 to 200 lbs. per acre. In cold wet seasons this would be of especial value.

Recent investigations indicate the best method of applying fertilizers for this crop is in bands on each side of the plant, about 3 to 4 inches below the surface and 2 inches away from the plant.

PLANTING: The desirable young plant to plant into the field is a well branched, moderately sized stem plant about eight inches high of good gray-green colour, not a brilliant green. The first blossom cluster is just about ready to open so that the fruit on this early cluster is formed in the field. However, some growers prefer to have the first blossom cluster set before field planting.

For unstaked plants planting distances are 4 by 4 feet or 4 by 3 feet. The staked plants are spaced one foot between plants in the row and the rows 3 feet apart.

Staking provides the ripe fruit ten days to two weeks earlier than the unstaked method.

For home use wooden stakes, 1 by 1 inch or $\frac{3}{4}$ by $\frac{3}{4}$ inch and 5 to 6 feet in length and driven down about one foot into the soil are used. For commercial use the small diametered iron rod is used, driving it into the soil about 15 inches. This rod may or may not be supported at the top by wire, suspended above these stakes.

PRUNING: Each plant must be pruned to a single stem by removing the very young branches which grow in the axils of the leaves and this single stem.

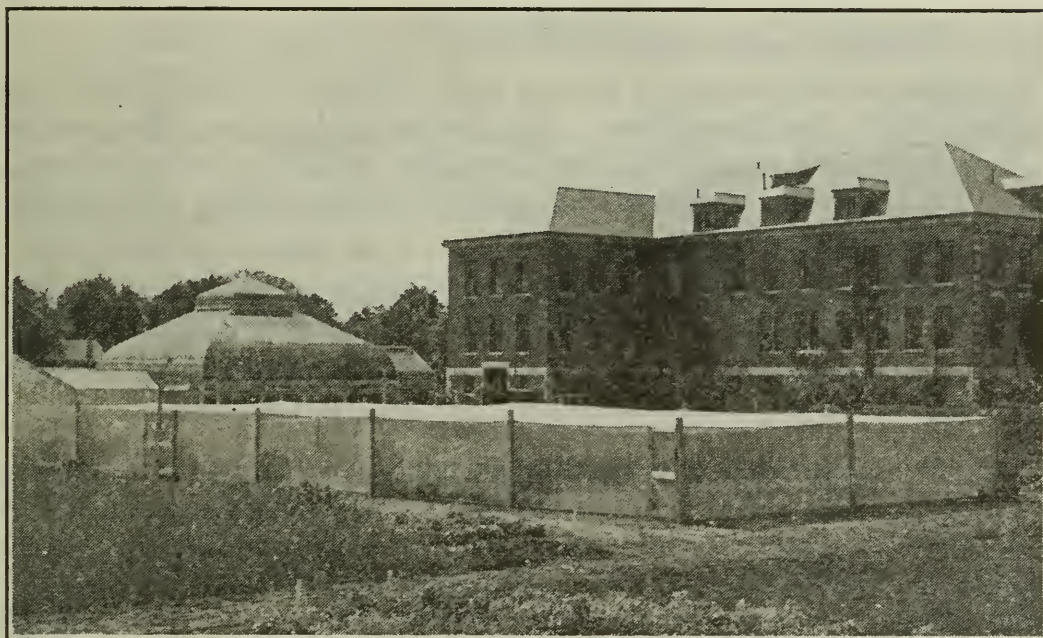
Only three or four clusters of fruit are grown on each plant for the staked crop. When the top blossom cluster has set or the first tomato of this top cluster has formed the top of the single stem is cut off about two leaves above the top blossom cluster to prevent further growth and hasten fruit development.

CULTIVATION: Cultivation and hoeing of soil during the crop's growth in the field should be shallow and sufficiently frequent to control weeds.

VARIETIES:

Staked—*Sutton's Earliest of All* is considerably grown. *Grand Rapids* is grown to a limited extent.

Unstaked—*Earliana*. Secure smooth strains of this variety. *Abel*.



Cloth House at Department of Horticulture, Ontario Agricultural College

The Cloth House is particularly suited to the growing of asters and some other flowers. It may also be useful in the home garden for vegetable crops, as it largely prevents insect attacks. Horticultural Buildings in background.

VEGETABLE STORAGE

Vegetables breathe during their storage and growing phases of life, taking in fresh air (oxygen) and giving off the gas, carbon dioxide. High temperatures of these products cause their rapid breathing which effects chemical changes inside the vegetables, shortening their natural life. Contrasted to these conditions low temperatures of the vegetables cause their slow breathing which slowly establishes these chemical changes in the vegetables and thus aids in the extension of their healthy existence. Desirable storage temperatures should remain constant throughout the duration of the storage phase of the life of the vegetables.

Vegetables also give off moisture during their growing and storage periods. The proper humidity or the moisture in the air surrounding the vegetables in storage is important. Excessive amounts of moisture in the storage room air provide ideal living conditions for organisms causing decay, while the marked insufficiency of this moisture causes wilting. An earthen floor, the placing of containers of water in the storage, and the dampening of the floors aid in increasing the amount of moisture in the air of the storage.

Air temperatures in common storage are mostly dependent on the prevailing outside air temperatures. With common storages ventilation usually comprises the opening and closing of windows, doors and ventilators. Temperatures of air in cold storages are controlled by the amount of the freezing agent applied to the air in the storage room.

To admit outside fresh air and drive out moisture-laden and impure air from common storage ventilation is conducted to effect the maintenance of uniform temperature and moisture conditions. To maintain constant temperatures as much as possible in the common storage the storage should be opened when the outside temperature is near freezing at any time or at night if warm weather exists. The cool storage should preferably not be ventilated during warm days because the air and products in the storage are heated, and also the moisture from the warm air, admitted to the cooler storage from the outside atmosphere will be deposited on the cool products — a distinctly undesirable condition.

Of fundamental importance in storage is the necessity of having the vegetables to be stored entirely free from disease, cuts, bruises and cracks. The most efficient storage environment of temperature and humidity of air surrounding the stored products will not prevent the growth and spread of disease which may exist in these products at commencement of storage.

STORAGE CONDITIONS: *Beets, Carrots, Parsnips, Salsify, Turnips*; — temperature 32 degrees F. to 33 degrees F., with high relative humidity to prevent wilting. Pile in small piles to prevent heating and decay. Parsnips are satisfactory to remain in the field soil all winter. These vegetables are often pitted.

CELERY: Winter varieties of celery for late winter and Christmas markets may be removed from the field before frost occurs with considerable earth adhering to the roots and stored preferably on an earthen floor of a common storage cellar. The roots should be totally covered with soil which must be kept moderately moist throughout storage. The tops of the celery should always be dry; the storage well ventilated, and the temperature of the air in the storage should be as near 32 degrees to 33 degrees F. as possible. The celery can be slightly blanched at the commencement of storage because blanching will be satisfactorily conducted in these storage conditions. When stored under refrigerated conditions every care should be used to place only high quality celery in crates which are maintained in the above temperature in spaced rows and tiers.

CABBAGE: The Danish Ballhead is the only suitable variety for winter storage. The desirable temperature of the air in the storage is 32 degrees F., combined with a moderate humidity because common storage rots rapidly develop in an excessively moist air; and wilting ensues in distinctly dry conditions. Moisture from the air in storage must never be allowed to condense on the stored cabbage. In the common storage slatted shelves, one above the other are erected throughout the storage with aisles between so as to hold one layer, and oftentimes two or three layers are placed on a shelf. Previous to placing on shelves the stem and much of the outside leaves are removed. Sometimes too, long piles of six to eight cabbages in width and height, with two to three feet between the piles are placed in common storage.

PITTING CABBAGE: This variety is pitted in long narrow pits of soil with five cabbages wide at the bottom tier, gradually sloping to one cabbage wide at the top tier. Ventilation is made at about fifteen feet intervals at the top of the pit.

ONIONS: The correct preparation of this commodity for storage is of primary importance to enable efficient storage conditions to be successful. Subsequent to pulling and topping the onions are placed two or three deep on slatted trays or in slatted crates. These crates or trays are stacked in piles with air spaces between piles in open sheds or in fair weather in the field for thorough drying. The preparation with sorting aids in producing for storage the necessary well ripened, thoroughly cured, dry, firm onion.

Subsequent to thorough drying these crates or trays are placed in storage. In storage the crates or trays are superior to bags; while bags are preferable to bins. The piles of bags or crates should be separated to permit air circulation. One foot deep of onions is ample in the bins.

Dry air and floor conditions are absolutely necessary for successful onion storage. Consequently ample ventilation is required and accomplished by providing an intake of fresh dry air on the floor and an outlet for the warm moist air at the ceiling. Damp foggy atmosphere should not be allowed to enter the storage. The floors of the storage should be slated. The storage temperature for onions is 32 degrees F. Onions are not pitted.

POTATOES: The storage temperature is from 38 to 40 degrees F. with a relative humidity of about 85 percent. The requisite ventilation can be secured by the free circulation of air around and beneath bins which consist of slatted floor and double slatted partitions providing an air space between bins. These slatted bins aid in removing from the vicinity of the potato all products formed by its breathing; assist to equalize the temperature within the bins and prevent sweating. Pitting is used satisfactorily for potatoes.

BULLETIN 389

JANUARY, 1938

Ontario Department of Agriculture

Statistics and Publication Branch

TORONTO, ONTARIO

THE "V" PEACHES

BY

W. H. Upshall and J. R. van Haarlem

HORTICULTURAL EXPERIMENT STATION

VINELAND STATION, ONTARIO



VIMY

VEDETTE

VALIANT

VICEROY

VETERAN

TABLE I.

COMPARATIVE DESCRIPTIONS OF "A" PEACHES

	LEAVES*		BLOSSOMS	FRUIT				PITS			
	COLOUR	SIZE		DATE 1ST PICKING†	SHAPE	COLOUR	CLING- NESS TO PIT	COLOUR	PITTING	WIDTH	THICK- NESS
Vimy	Light green	Large	Large (Sterile)	Aug. 22	Oval	Bright red streaks	Free	Light red	Deep	Very wide	Thick
Vedette	Dark green	Medium	Large	Aug. 25	Oval	Bright red streaks	Free	Deep red	Shallow	Narrow	Flat
Valiant	Light green	Small, narrow at base	Medium	Aug. 30	Round to oval	Dull red streaks	Free	Light red	Deep	Wide	Thick
Viceroy	Dark green	Medium	Large	Aug. 31	Oval	Bright red streaks	Slightly clingy	Light red	Deep	Medium	Medium
Veteran	Dark green	Medium	Large	Sept. 6	Nearly round	Mostly a blush, some bright red streaking	Slightly clingy	Light red	Deep	Medium	Medium

*All of these varieties have kidney-shaped glands at the base of the blade of the leaf.

†September 17th is the average date of first picking of Elberta at Vineland Station.

THE "V" PEACHES

Distinguishing Characteristics of Vimy, Vedette, Valiant, Viceroy and Veteran

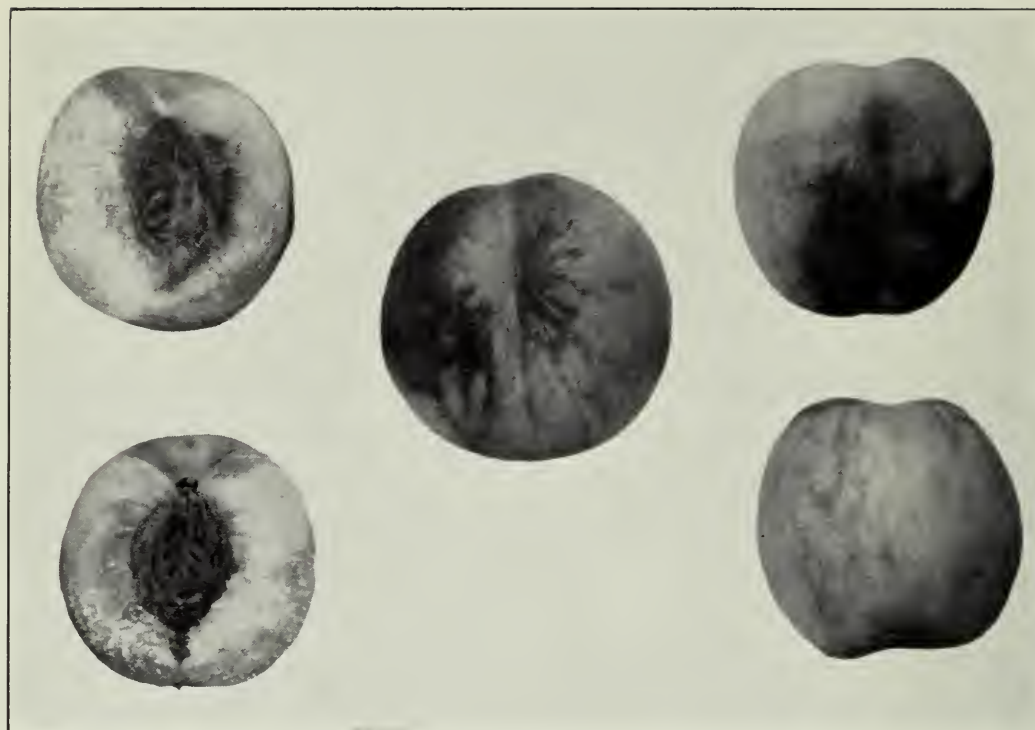
W. H. UPSHALL AND J. R. VAN HAARLEM

BECAUSE there is already some confusion in nomenclature of the peaches originating at the Ontario Horticultural Experiment Station, commonly known as the "V" peaches, it seems desirable to give at this time fairly complete descriptions of the leaves, blossoms and fruits of these varieties. Such is the main purpose of this publication. In addition, a few notes on their commercial value in Ontario as far as it can now be judged, will be given. Table I (opposite) and Figures 1-6 give sufficient information to ensure identification of any one of these varieties in the orchard. Figure 1 illustrates the differences in shape and colouring of the five varieties, and Figures 2-6 present views of each variety from all angles.

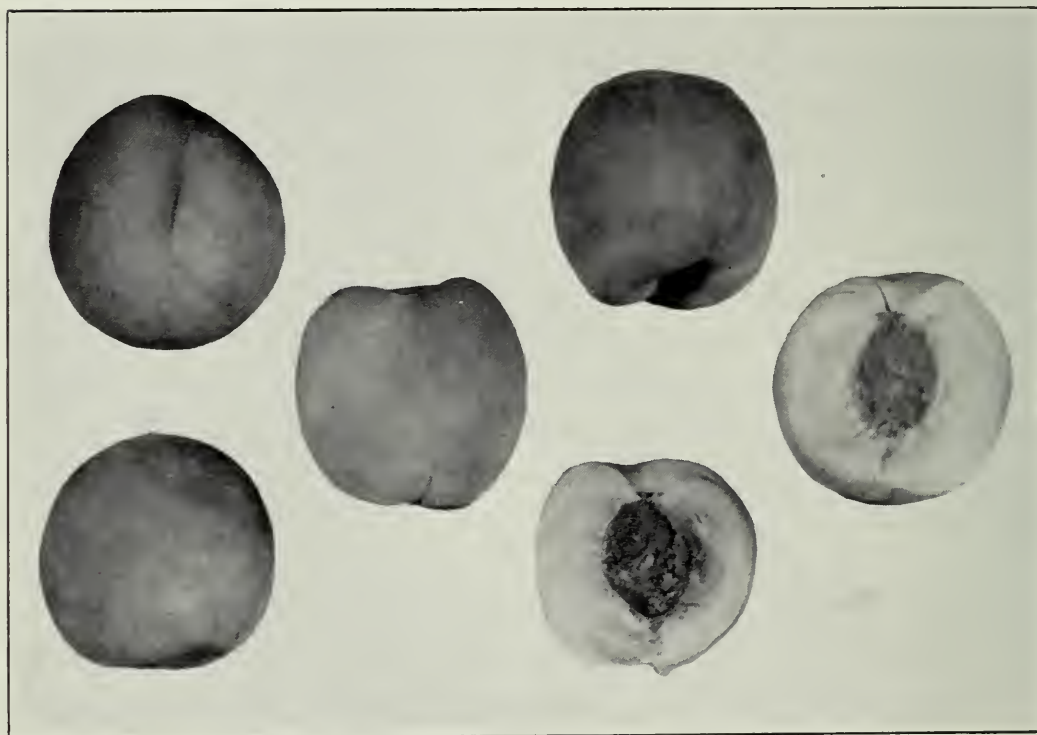
In the nursery one is limited largely to leaf characters for differentiation, and as all of these varieties are related to Elberta, they possess many foliage similarities which make identification of young trees very difficult. Therefore, though it is not impossible to identify these varieties in the nursery row, it cannot be done without long continued study. The shade of green colour of the leaves is most useful but unfortunately the differences are so small that no colour naming system can be used in describing them.

All the "V" peaches except Vimy bear heavy crops and will therefore require **heavy thinning and good soil fertility conditions** in order to ensure satisfactory size of fruit, particularly on old trees. Growers are finding that the "V" varieties require more attention to these factors than the Elberta variety. Unlike Elberta, the "V" peaches hang well to the tree until they are past the regular picking stage of maturity.

Very little is known about wood hardiness in these varieties but the winter of 1933-34 gave some indications regarding the hardiness of the fruit buds. In that year their rank in order of decreasing bud hardiness was:—Veteran, Vimy, Viceroy, Vedette and Valiant, with the latter variety of about the same bud hardiness as Elberta.



VIMY



VEDETTE

Vimy (Seedling No. 16016)

Vimy is the result of a cross between Elberta and Arp Beauty made in 1916. It was named and sent out for testing in 1924. Because it appeared to be a shy bearer in some years and as it ripened at about the same time as Vedette, a regular bearer, it was not recommended for general planting. However, to a limited extent, it got into the nursery trade under the name of Vedette and most of the plantings of Vimy have happened in that way. Some growers planted these trees in solid blocks, and as it is a self-sterile variety, crops have been disappointing. Some growers who have the variety well interplanted with self-fertile varieties have been getting sufficient crops in most years with thinning of fruit necessary only occasionally. Vimy has received much publicity because of its large-sized fruit which, however, has been mainly the result of light to moderate crops. Even with adequate interplanting of pollinating varieties it is still doubtful if Vimy will produce satisfactory yields over a period of years. In any case, in a Vimy orchard a minimum of every third tree in every third row should be some good pollinating variety. June Elberta (Mikado), and J. H. Hale being self-sterile, would not be satisfactory for this purpose.

Vedette (Seedling No. 150369)

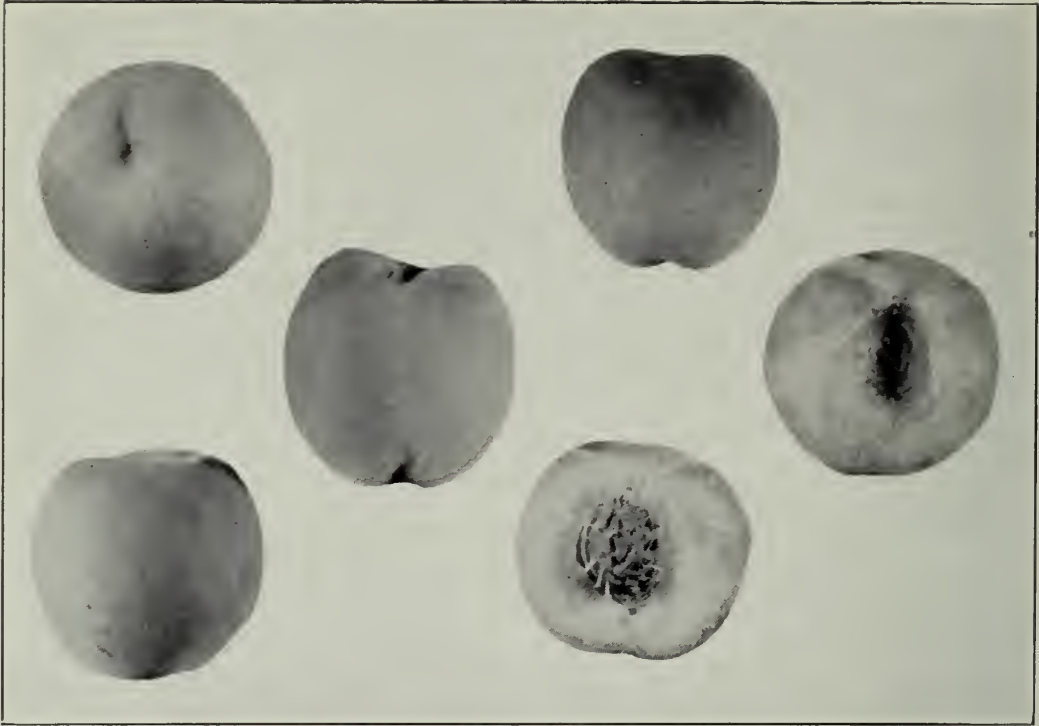
Vedette is an open-fertilized seedling of Elberta, originating from seed saved in 1915. It was named and introduced in 1925. It is now very widely planted, and is highly esteemed for fresh fruit and canning purposes. The bright red streaks on the cheek of Vedette peaches make them very attractive to the buyer.

Valiant (Seedling No. 174770)

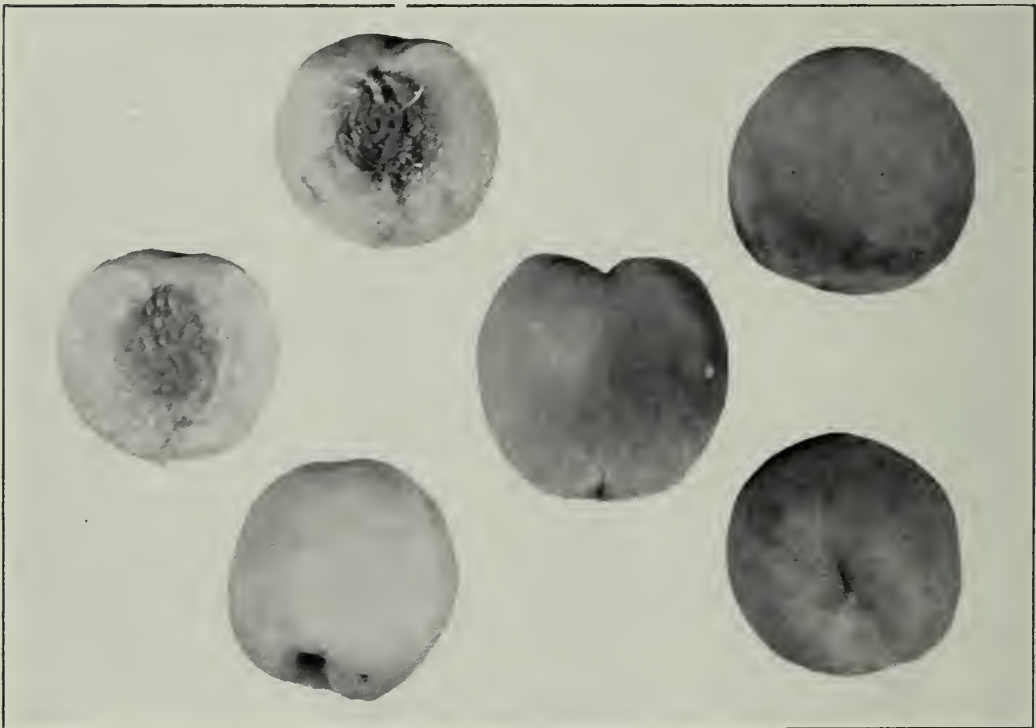
Valiant is also an open-fertilized seedling of Elberta but it came from a seed saved in 1917. Like Vedette it was named and introduced in 1925. It has been just as heavily planted in Ontario as Vedette, or perhaps more so. Some reports indicate that it holds its size of fruit better than Vedette as the trees become old. However, there is still a good deal of argument as to which is the more valuable of these two varieties. Anyway they differ enough in their ripening season to allow for the planting of both varieties in the same orchard. Because of its darker cheek colour Valiant is not as attractive a peach as Vedette but is equally good in quality both in the fresh state and as a canned product.

Viceroy (Seedling No. 194055)

Viceroy resulted from a cross between Vaughan and Stark's Early Elberta made in 1919. Vaughan is a self-fertilized seedling of Leamington resulting

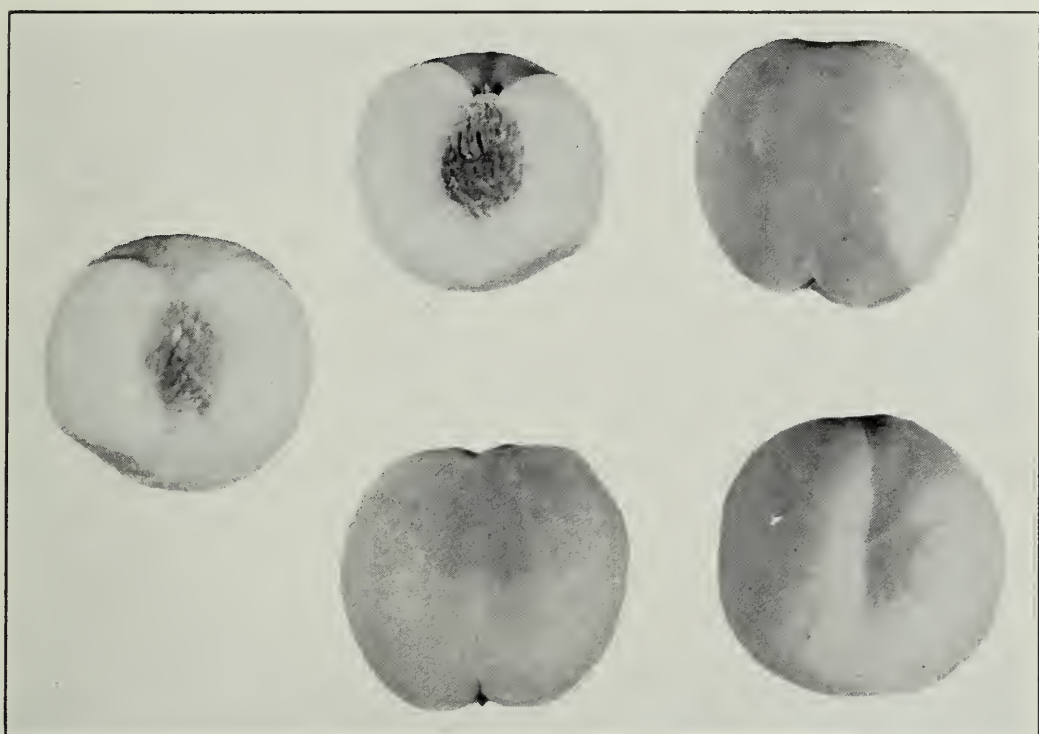


VALIANT



VICEROY

from the breeding work of 1913. Vaughan is not now being planted but was used in breeding work because of its high degree of fruit bud hardiness, some of which has been inherited by Veteran, the hardiest in bud of all the "V" peaches. Viceroy was named and distributed for test purposes in 1929. It has never been recommended for general planting and it is doubtful if there is a place for it. Some years the flesh clings to the pit enough to be objectionable in canning work, and ripening with or very near to Valiant, it has no point of superiority to the latter except possibly a slightly more attractive appearance due to its brighter red colouring.



VETERAN

Veteran (Seedling No. 1940208)

Veteran, a sister seedling of Viceroy, came from the same cross in the same year. It was named and introduced in 1928. The variety has been very widely planted. It seems to be particularly affected by a lack of available potassium in the soil, in which case the fruit ripens ahead of its regular time, and is lacking in surface colour and flat in taste. Some years the flesh clings to the pit to a certain extent and this characteristic has been found objectionable by some commercial canning companies. However, Veteran has been canned in large quantities and probably will be used until a perfect freestone peach of equal quality appears on the market for the same season.



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BULLETIN 390

MARCH, 1938

Ontario Department of Agriculture

Statistics and Publication Branch

TORONTO, ONTARIO

Successful Potato Production in Ontario

By the Staff of the

ONTARIO AGRICULTURAL COLLEGE

Guelph, Ontario



A Championship Half Bushel of Potatoes

SUCCESSFUL POTATO PRODUCTION IN ONTARIO

By

The Staff of the Ontario Agricultural College

IN Ontario the extensive production of potatoes is confined to specialized areas, but a potato plot of some kind is to be found on practically every farm. In this pamphlet an attempt is made to point out the most suitable varieties and the best production practices as shown by careful experiments and by experience of the most successful growers.

CERTIFIED SEED IS MOST IMPORTANT

Good seed is fundamental to the production of good crops of high quality potatoes, regardless of whether the crops are intended for seed or for table use. APPARENT soundness of the seed tubers constitutes no guarantee of freedom from disease, for, notwithstanding good appearance, they may carry virus diseases which are not recognizable in the tuber, but which, nevertheless, seriously affect the yield and quality of the crop.

Certification is a means of recording seed tubers grown from certified seed. Certified seed does not mean seed potatoes that are entirely free from all diseases or blemishes, for such a result is not possible under quantity production, but every effort is made to certify potatoes only from fields that are well kept, that are practically free from disease, and where plants are vigorous and true to variety. Commercial potato growers whose own potatoes are badly infected with disease or contain mixed varieties will find it decidedly advantageous to plant certified seed of such varieties as are available, even though they may not ordinarily be considered as the most suitable varieties for their particular district. If the official tag is not on each and every container, the potatoes in them should not be accepted as certified seed.

Good seed has been made available to the potato industry by this system of potato certification, and commercial growers should take advantage of the opportunity to secure a supply. At present most of the Canadian certified seed is exported to foreign markets where its high quality is recognized and where a million and a half bushels are required annually to fill the demand.

A grower can have no assurance of a good marketable crop of high quality potatoes unless he uses good seed.

In cutting seed potatoes, discard all that show any signs of disease such as rots, scabs, rhizoctonia (small, black, hard surface specks on the skin), brown rings in the stem end, and all badly off-type tubers. Use two knives, keeping one in a dish of formalin. If any diseased potato is cut, discard it, drop the knife into the formalin and use the other knife which will have been

disinfected by the formalin. The first knife will be ready to use again should another diseased potato be cut.

GOOD VARIEIES ARRANGED IN ORDER OF EARLINESS OF MATURITY

WARBA:

The Warba is a variety recently introduced to Ontario. It resembles the Irish Cobbler in general shape of tuber, but has pink eyes. It matures about a week earlier than the Cobbler, and has good table and keeping qualities. It is the highest yielding of our early maturing varieties, and during the past three years has gained in popularity in Ontario.

IRISH COBBLER:

The Irish Cobbler is the most extensively grown, early maturing potato in Ontario. It is a white, smooth-skinned, deep-eyed potato whose tubers are roundish with blunt ends, the stem end often being notched rather deeply, giving a shouldered appearance to the tuber. Because of its earliness it escapes many of the potato diseases. It also has good cooking and keeping qualities which it maintains.



Typical Dooley Potato

CHIPPEWA:

The Chippewa is a white, oblong, shallow-eyed potato. It is a new variety introduced by the United States Department of Agriculture, and is already quite popular in the United States. For the past two years it has been grown in an experimental way in Ontario. Its tubers resemble those of the Katahdin, but it ripens about a week earlier than this variety and three weeks earlier than the Dooley. Because of this it is meeting with considerable approval from the growers. One of the disadvantages of our present main crop varieties is their immaturity at digging time.

KATAHDIN:

The Katahdin is a white, oval-shaped, shallow-eyed potato, originated by the United States Department of Agriculture. It has been grown at the Ontario Agricultural College since 1929, and, in addition, its performance has been studied on many good potato farms for the past six years. During this period it has proven to be a potato of outstanding merit. Under average conditions it ripens about seven days earlier than the Green Mountain and twelve days earlier than the Dooley. Its yield of total crop and percentage of marketable potatoes are similar to that of the Dooley, while its table quality, in appearance and flavour, is superior. It also has a high degree of resistance to Mild Mosaic and is rapidly increasing in acreage and popularity in Ontario.

GREEN MOUNTAIN:

The Green Mountain is distinctly oblong and flattened, with the ends usually blunted. The skin is a dull creamy white, and more or less netted. The surface is inclined to be irregular with rather shallow eyes. This variety is better adapted to heavier soils than is the Dooley, and produces larger yields of good quality tubers. It is fairly late in maturing, but is about five days earlier than the Dooley. It is quite susceptible to disease, and because of this is gradually losing favour in Ontario, even though its table quality is good. When cooked it has a good appearance with good mealiness and flavour. This variety gives best results in the cool northern sections, but is not so suitable to the southern parts of the Province.

DOOLEY:

The Dooley is a white, smooth-skinned, shallow-eyed potato which is slightly oblong and flattened in shape. It produces fair yields of a high percentage of marketable tubers. This variety does best on warm, sandy soils, and is not suited to Northern Ontario. It possesses a high degree of resistance to Mild Mosaic and some tolerance to Scab, but is quite susceptible to Fusarium Wilt. It is late in maturing, being about twenty-two days later than the Cobbler. In most seasons it is immature at digging time with the result that it is apt to peel or feather considerably when being harvested. It is a good keeper, but its table quality is only fair, as, when cooked, it is inclined to be dark and slightly bitter in flavour.

CLIMATE AND SOIL

The potato thrives best in a rather cool climate with moderate rainfall.

In Ontario potatoes are grown on a great variety of soils. Rich, friable, sandy loam or clay loam soils with good moisture holding capacity are most suitable. On the lighter soils potatoes are usually of better shape and freer from disease, consequently our main potato growing areas are in regions where such soils prevail.

ROTATION

For best results potatoes should not be grown on the same ground more than once in three or four years, and it is well to plant potatoes on land which has been in clover or alfalfa sod for one or two years previously.

MANURES AND FERTILIZERS

There should be plenty of humus in the soil to furnish plant food and retain moisture. This is best supplied by barnyard manure and green manuring crops such as clover aftermath and winter rye. Where barnyard manure is used it is desirable to apply it in the summer previous to that in which potatoes are planted. On farms where the land is reasonably level the manure may be applied to advantage during the winter previous to the ploughing of the sod. Barnyard manure applied at the rate of 12 loads (20 tons) per acre will give good results. Half of this quantity of manure on a clover sod, supplemented with from 500 to 750 pounds per acre of an 0-12-10 or an 0-12-15 commercial fertilizer is recommended.

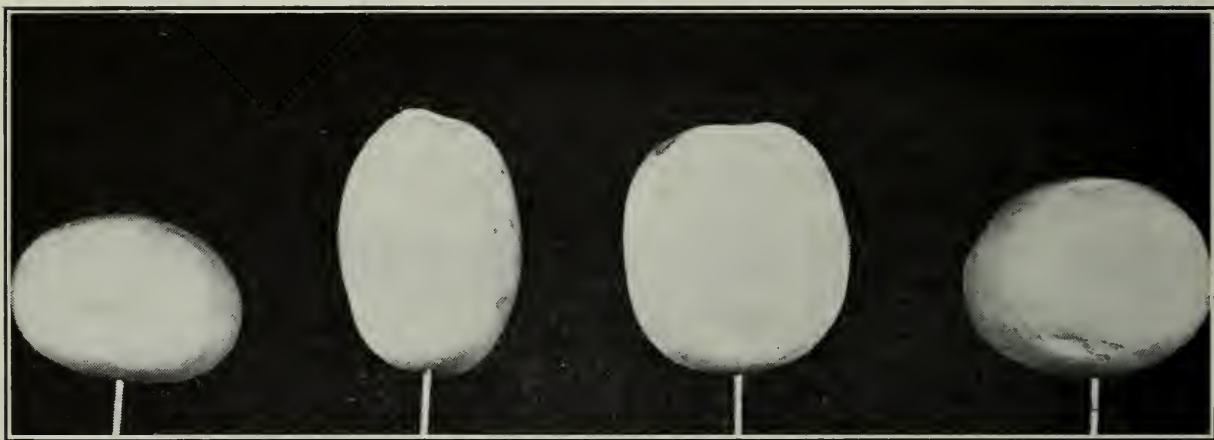


Typical Green Mountain Potato

The average of a large number of fertilizer tests on representative potato soils where no manure is used indicates that a 4-8-10 applied at the rate of 750 pounds per acre is satisfactory. This is best applied in two 1 inch ribbons, one on either side of the potato seed pieces, separated from the potato pieces by about 1 inch of fertilizer-free soil, and on a level with, or slightly below, the potato pieces. This application is usually accomplished by modern potato planters. If the grower does not have a planter, the next best way is to strike out a plow furrow for the potato row, and scatter the fertilizer evenly down the plow furrow at the desired rate. Then pull in about $\frac{1}{2}$ inch of soil on top of the fertilizer, drop the potato seed pieces along the furrow, and proceed as usual. It is suggested that the fertilizer requirements of any soil should be determined by special tests before any definite rate or formula is decided on.

PREPARATION OF THE SOIL

The sod should be plowed in July or August when there is considerable aftermath present for green manure. As soon as the land is plowed it should be compacted with either a roller or packer and this should be followed by a disc-harrow or a harrow in order to establish a mulch. The mulch is necessary in order to conserve moisture for the decomposition of the vegetable matter in the soil. As soon as the sod has rotted sufficiently, cultivation should be given in order to incorporate the vegetable matter with the soil, to germinate weed seeds, make plant food available, and render the soil conditions unfavourable to the development of the scab organism. The ground may then be seeded to winter rye, but not later than October 1st.



Typical Chippewa Potato

METHODS OF DISINFECTING SEED POTATOES

Disinfecting seed potatoes helps in the control of such diseases as Blackleg, Common Scab, Black Scurf or Rhizoctonia and Powdery Scab. They should always be treated before they are cut and if possible before they have started to sprout, as the treatment destroys the sprouts and thus retards the growth.

A convenient method for handling potatoes when treating them is to place wooden barrels on a platform in such a manner that the solution used for treatment can be drained off from the bottom of one barrel before removing the potatoes, and added to another barrel.

Bags used in the operation of treating potatoes should not be used to hold potatoes intended for food. No treated potatoes should be put into containers which have not previously been disinfected.

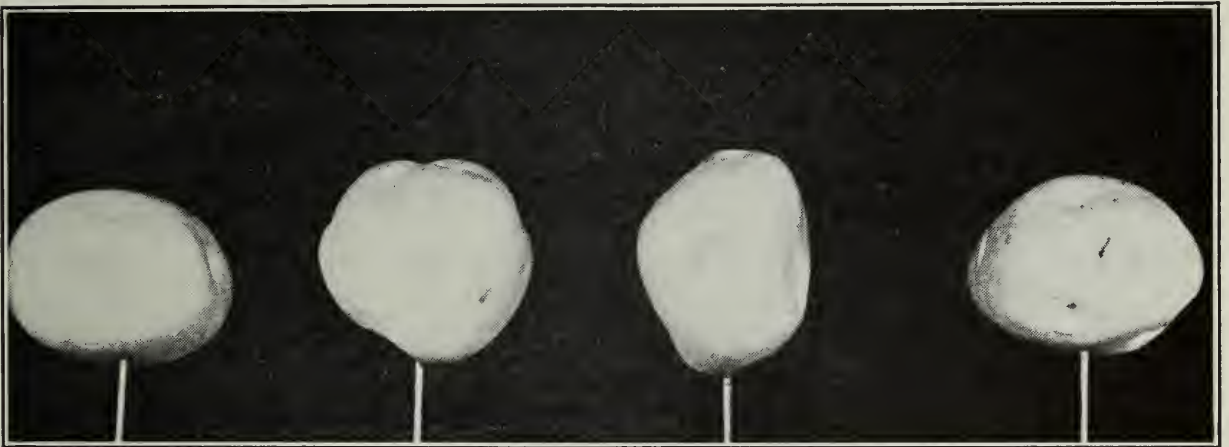
There are many methods of disinfecting seed potatoes. Two of the most effective are described below.

THE ACID CORROSIVE SUBLIMATE TREATMENT

(This treatment is recommended for the control of Black Scurf or Rhizoctonia, Blackleg, Common and Powdery Scab.)

It consists of dipping the seed potatoes, before they are cut, for ten minutes in a solution made by stirring 8 ounces of corrosive sublimate (mercuric chloride) in a quart of commercial hydrochloric acid and diluting to 25 gallons with water. This solution may safely be used for ten treatments, and if the duration of dipping is increased to fifteen minutes, for a further five. The potatoes should be immersed unbagged, and afterwards dried. The treatment may be carried out some weeks or even months before planting. This treatment is not costly and it is effective.

N.B.—If this treatment is used, be sure to spread the potatoes out to dry immediately afterwards. Otherwise serious injury may result. Corrosive sublimate is a deadly poison and should be kept out of the way of children and live stock. Potatoes disinfected with it should never be used for food for man or beast.



Typical Irish Cobbler Potato

CORROSIVE SUBLIMATE TREATMENT

(This treatment is also recommended for the control of Black Scurf or Rhizoctonia, Blackleg, Common and Powdery Scab.)

If a large tank or trough is available, soak the seed potatoes in clean water for five to ten hours. If no large tank is available, place the potatoes to be treated in a pile on the barn floor, sprinkle them thoroughly with water and cover them with wet sacks, and leave for twelve hours. At the end of this time soak them for an hour and a half in a solution of corrosive sublimate of the strength of 4 ozs. of corrosive sublimate in 25 gallons of water. In preparing this solution, dissolve the corrosive sublimate in a little hot water, then add it to 25 gallons of cold water. Fill a barrel or trough with the potatoes, then

add the solution until the potatoes are covered. Leave for the required time, then drain off the solution into another receptacle. After each lot of tubers has been treated, add half an ounce of corrosive sublimate and keep the volume of the solution constant by adding more water when necessary. After four lots of tubers have been treated the solution should be discarded and a fresh lot used.

TIME OF PLANTING

Late planting is one of the chief causes of reduced yields, and of immature potatoes which are easily injured in harvesting and handling. According to results at the Ontario Agricultural College each day's delay in planting, from early May to mid-June, resulted in approximately 1½ bushels reduction in yield per acre per day. Recent experiments in Middlesex County indicate that from the 15th to the 25th of May is the most desirable time for planting. Late planting increases the danger of frost injury, etc., and produces a product of inferior marketing qualities.

RATE OF PLANTING

In Ontario potatoes are generally planted with the rows 30" to 32" apart and the sets placed at 12" to 14" apart in the row. The distances apart depend to a certain extent on the type of plant of the variety grown. Some varieties, such as the Katahdin, require closer planting than others.

Tests conducted at the Ontario Agricultural College indicate that sets should weigh about 1½ ounces and possess at least two eyes.

The quantity of seed required per acre varies with the size and spacing of the sets and the distance between the rows. With 30" between the rows and the sets 12" apart, 27 bushels of seed will be required. With the same distance between rows and the sets 14" apart, 23 bushels per acre will be needed.

DEPTH OF PLANTING

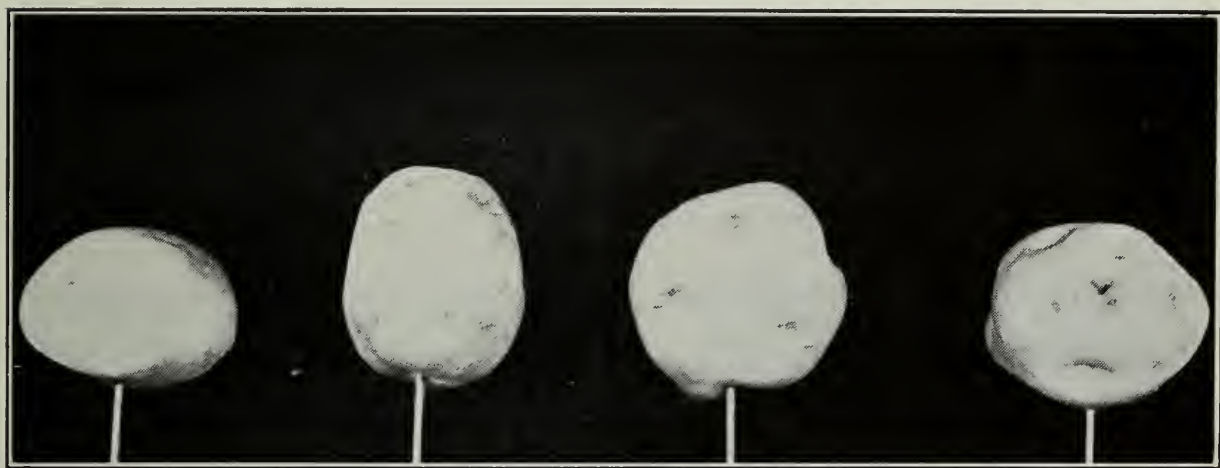
As a general rule, for the main crop the seed should be placed about 4" below the ground level. The tendency with modern planters is to deposit the seed much shallower than this. Such a practice results in an abnormal drying out of the soil surrounding the seed.

CULTIVATION

Experiments at the Ontario Agricultural College indicate that where the seedbed has been thoroughly prepared shallow cultivation through the growing season is the most satisfactory. Cultivation should be frequent enough to control weeds and conserve moisture. Sufficient moulding should be done to prevent sunburn of the tubers.

DIRECTIONS FOR SPRAYING POTATOES TO PREVENT LATE BLIGHT AND ROT AND CONTROL INSECT PESTS

Commence spraying when the potato beetle eggs are just hatching, which will usually be when the potato plants are from five to eight inches high, and keep the foliage covered with Bordeaux throughout the season, taking special precautions to see that it is well covered during wet weather. Do not put off spraying because it looks like rain, for, once dry, the spray mixture will remain on the leaves and be on at the critical time. This statement will be understood when it is realized that infection takes place during or immediately after rain. For the first application use Bordeaux mixture



Typical Warba Potato

(formula—4 pounds copper sulphate, 5 pounds hydrated lime and 40 gallons of water). Add 2 pounds of arsenate of lime (calcium arsenate) to each 40 gallons. Repeat the spraying often enough to keep the foliage well covered. Add the arsenate of lime to the Bordeaux only when required for potato beetles. No stated number of sprayings with the Bordeaux can be recommended; the number depends on the weather—the wetter the weather the larger the number. Four to seven sprayings are often necessary. If the season is favourable for Blight and Rot, continue the spraying until the plants have finished their growth and died or have been destroyed by frost. It is very important to use plenty of Bordeaux at each application. Forty gallons may be sufficient to cover an acre of potatoes when the plants are small, but when the plants are large from eighty to one hundred gallons or more may be required for each acre. The best results are obtained by applying the Bordeaux under high pressure in the form of a fine mist so as to cover both surfaces of the leaves. High power sprayers with a pressure of 200-300 pounds and which deliver plenty of the Bordeaux to cover the vines thoroughly are the most satisfactory machines for spraying.

Dusting is sometimes practised instead of spraying, and in many seasons it is quite satisfactory. Careful experiments have shown, however, that in wet seasons dusting is not so effectual against blight, and on the whole the results from dusting have not been as satisfactory as those from spraying. Some growers prefer dusting to spraying because it requires less time. The best results from dusting are obtained from frequent and heavy applications of copper lime dust, with calcium arsenate added when an insecticide is also required.

HARVESTING

Digging may be done with a regular potato digger or with a plow, preferably equipped with tines to bring the potatoes to the surface.

Where the grower has a cool dry storage place, and when the crop is free from late blight or rot, digging should be done as soon as the potatoes are mature. Under blight conditions, and providing the weather is not very wet, it is better to defer digging as long as possible. By so doing diseased tubers can be more easily detected and discarded before the crop is stored.



Typical Katahdin Potato

GRADES

Where potatoes are intended for sale they should be graded according to the grades defined in the Dominion Fruit, Vegetable and Honey Act.

STORING

Potatoes should be as dry as possible before being stored. All diseased or badly damaged tubers should be removed. Many thousands of bushels are lost each year by the inclusion of such tubers which encourage serious rotting.

Storage temperatures of 33 degrees to 37 degrees F. are the most satisfactory for seed stock. Potatoes intended for table use should be stored at

temperatures of 38 degrees to 42 degrees F. Lower temperatures than 38 degrees F. tend to cause a sweet flavour. Storing tubers in the basement of a dwelling is not usually satisfactory due to the difficulty of providing proper ventilation and temperatures.

A specially constructed storage cellar is usually the most satisfactory. Such structures are provided with adequate systems of ventilation and are built to exclude both light and frost.

Where such permanent storage facilities are not available a temporary pit may be used with a fair degree of satisfaction. Such pits should be located in a well drained position and are usually made in the form of a trench of sufficient dimensions to accommodate the quantity of potatoes which it is desired to store. Small, temporary ventilators are installed at regular intervals in the pit. The sides of the pit may have to be lined with boards to hold the soil in place. The top is usually constructed of supporting poles which bear the weight of succeeding layers of straw and soil of sufficient thickness to keep out frost.

During very cold weather it may be necessary to close the ventilators temporarily to prevent the pit temperatures from getting too low. A thermometer attached to a string may be lowered down the ventilators to determine the pit temperature.

GROWING CERTIFIED SEED POTATOES

The production of certified seed potatoes requires particular care but produces the finest quality of seed available. For information concerning the steps necessary to produce the best quality of seed write to the Ontario Agricultural College, Guelph.

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BULLETIN 391

MARCH, 1938

Ontario Department of Agriculture

Statistics and Publication Branch

TORONTO, ONTARIO

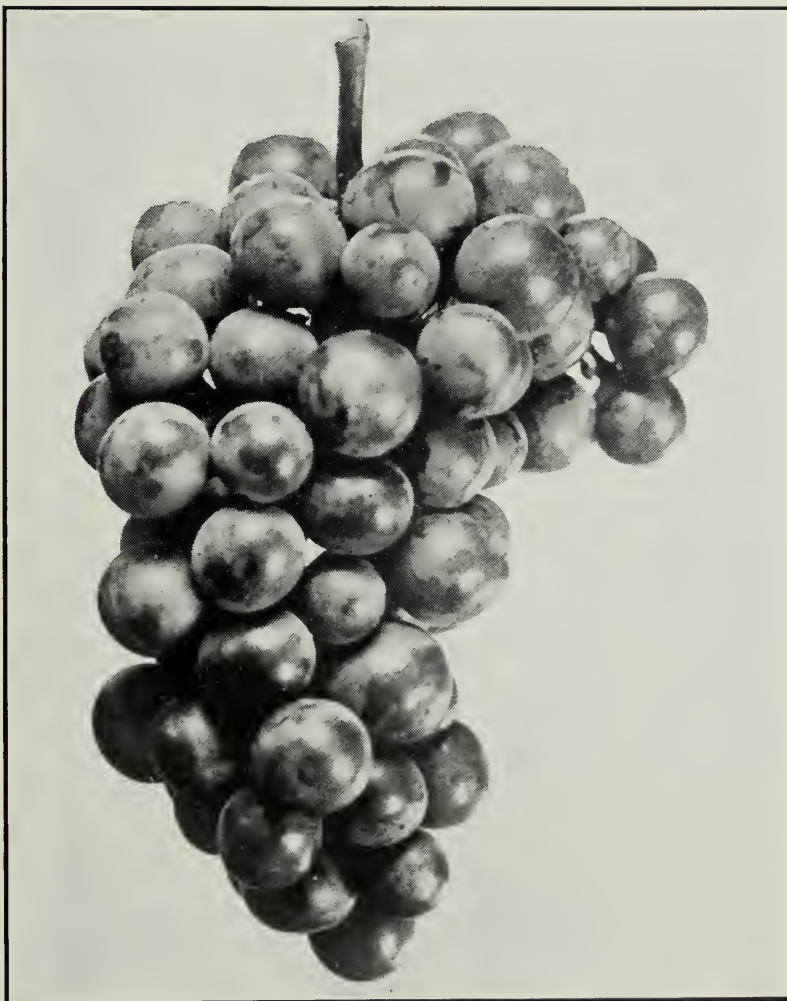
THE GRAPE IN ONTARIO

BY

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VINELAND STATION, ONTARIO



THE GRAPE IN ONTARIO

E. F. PALMER AND J. R. VAN HAARLEM

INTRODUCTION

BECAUSE of the continued demand for information concerning the growing and management of grapes, an endeavour has been made to set forth in this revised bulletin all the latest information available concerning new methods of vineyard management, and the newer varieties.

During the last few years our knowledge of soil fertility has undergone considerable change. A better appreciation of the role of organic matter as the basis of a permanent fertility program has necessitated some revision of former methods of management.

Also, during the last few years new and superior varieties of grapes have been introduced and have demonstrated their ability to replace some of our older varieties which, at their best, had some very serious faults.

THE GRAPE IN ONTARIO

In Ontario, grape culture is of comparatively recent origin. The first record of planting that has been brought to the attention of the writers is that of the small area set out on a farm at that time owned by Porter Adams, at Queenston, in the Township of Niagara, in the year 1857. The next year, W. D. Kitchen and J. R. Pettit planted some vines on their farms at Grimsby. In 1862, Wm. Read, of Port Dalhousie, planted three acres of Concord, Hartford Prolific and Delaware, and in the same year, Peter Wright, of Stamford, planted three acres of Isabella. In 1863, Mr. Lusee, J. M. Stewart, Henry Lottridge and Christopher Biggar all planted small vineyards. In 1868, F. G. Stewart, of Stamford, planted two and a half acres of Concord and Delaware, and Mr. Prest, of the same place, planted an acre of Delaware, Concord and Hartford Prolific. In 1869, Walter Kerr, of Drummondville, planted two acres of Concord and Delaware. In 1873, D. J. Lowry, of St. Davids, set out two hundred Concord, fifty Isabella, fifty Diana and fifteen Delaware vines. These were set in rows sixteen feet apart, the plants twelve feet apart, and were trained to chestnut stakes seven feet high. No special stimulus seems to have been given the industry until about 1882, when the much advertised "Niagara" variety was introduced. Vines of this variety were sold at \$1.25 each, and all cuttings had to be returned to the company. In spite of the high cost, a great deal of money was made from this variety during the years following its introduction.

As late as 1880 the province was credited with not more than 400 acres of commercial grapes. By 1890 this area had increased to 2,400 acres and by 1901 to 5,750 acres. The Dominion census for 1931 does not give directly

the number of acres in Ontario, but, based on the total number of vines reported, the acreage would be approximately 14,800. The distribution, as compiled from the Seventh Census of Canada (1931), is shown in the following table:

TABLE I. GRAPES, NUMBER OF VINES, YIELD AND VALUE, 1930-31

COUNTY	1931 NON-BEARING	1931 BEARING	1930 YIELD—LBS.	1930 VALUE
Lincoln.....	1,698,076	2,910,598	25,998,722	\$780,488
Wentworth.....	377,805	1,035,744	8,688,729	175,558
Welland.....	284,557	318,474	3,632,112	82,886
Essex.....	70,305	212,795	1,017,233	37,146
Halton.....	38,386	44,902	398,085	12,097
Kent.....	3,506	15,989	206,945	8,793
Elgin.....	18,219	16,925	187,960	7,873
Middlesex.....	23,383	21,553	138,660	3,174
Other Counties.....	38,508	59,391	726,897	18,488
Total for Province.....	2,552,744	4,636,371	40,995,342	\$1,126,503
Total for Canada.....	2,599,253	4,699,581	41,479,620	\$1,144,529

TOTAL ACREAGE AND YIELD OF GRAPES, 1931

	NON-BEARING	BEARING	TOTAL ACRES	AV. YIELD PER ACRE (TONS)
Ontario.....	5,274	9,579	14,853	2.140
Canada.....	5,370	9,710	15,080	2.136



(Fig. 2) A large yield per acre depends upon good management.

THE WINE INDUSTRY

Any attempt to discuss the culture of the grape in Ontario must take cognizance of the fact that the bulk of our grapes are now used for wine-making purposes. It is conservatively estimated that fifty-five per cent of the grape crop is used by the recognized commercial wineries, while a further ten per cent, or possibly more, is eventually made into wine. More liberal estimates place the total of grapes used for wine purposes at from seventy-five to eighty per cent, but such estimates seem unduly high when the figures in Table II. are analysed:

TABLE II.
ONTARIO GRAPE WINE PRODUCTION

YEAR ENDING OCTOBER 31ST	PRODUCTION IN GALLONS	ONTARIO SALES		EXPORTS		TOTAL TONNAGE GRAPES USED
		GALLONS	VALUE	GALLONS	VALUE	
1928	4,812,116	800,868	\$1,073,204	1,607,450	\$ 711,685	13,347
1929	5,921,536	1,752,903	2,169,418	1,766,656	1,237,979	19,271
1930	6,218,210	2,143,837	2,791,659	1,360,868	928,025	18,264
1931	2,799,465	2,101,208	2,916,646	1,183,936	1,013,076	11,849
1932	2,699,537	1,760,376	2,543,608	983,519	746,808	10,842
1933	1,658,395	1,508,094	2,379,712	932,220	817,979	7,843
1934	3,222,624	1,332,170	2,486,611	1,478,361	1,515,253	15,500
1935	2,241,531	1,311,742	2,620,735	1,312,395	1,355,226	8,297
1936	1,316,863	1,256,742	2,478,902	983,093	880,890	5,277
1937	Incomplete	1,576,510	2,917,595	1,121,635	992,331	14,784

The above figures were secured through the courtesy of the Liquor Control Board of Ontario. Further information for several years previous to 1925 was also given as follows: "In 1919, when the total number of wineries was from twenty to twenty-five, the estimated gallons sold were 263,310, estimated in value at \$411,578.00; in 1920, the corresponding figures were 342,776 gallons and \$528,193.00; in 1921, with the object of later getting figures for the provincial fiscal year, figures were asked for the first nine months of 1921, for which period the respective amounts were 195,843 gallons and \$346,382.00." These figures, together with those in Table II., indicate the rapid growth of the wine-making industry.

The main variety for wine-making purposes is, of course, the Concord. This is natural since this variety constitutes close to seventy per cent of the total grape acreage in the Niagara District. Other varieties, such as the Niagara for white wines, are used to a lesser extent.

Considerable experimental work needs to be done to determine the best varieties for wine-making, taking into consideration yield and other cultural factors, as well as actual wine-making qualities. The Catawba, for example, is an excellent wine variety, but on account of its late maturity it is not adapted to the Niagara Peninsula, though succeeding quite well on Pelee Island (Essex county). The Delaware has been largely used for wine purposes but for several reasons, chiefly yield and vigour of vine, it will likely never enjoy wide popularity from the growers' standpoint.

During the past ten years, in co-operation with two of the largest commercial wineries, the Experiment Station has tested many varieties and seedlings for their wine-making properties. From this work it has been determined that certain of the newer varieties and some of our own Station seedlings possess some very favourable characteristics for the production of specialized wines. Most of these varieties and seedlings have a higher sugar content than the Concord and might therefore make a finer finished wine.



(Fig. 3) Haines Vineyard, Jordan. Four acres of this vineyard are being used for soil fertility studies.

Since such a large proportion of the commercial crop finds its way into the winery, it might be time that we establish certain varieties for wine production only. The history of grape growing in the Peninsula shows that grapes were primarily grown for table use and that wine production followed. Most of our present varieties, therefore, have a dual purpose. This may be

safe insurance for the grower when he cannot market his crop through the winery outlet. On the other hand, other countries grow two types, one for dessert purposes and the other for wine. It is unfortunate that dessert and wine-making qualities do not go hand in hand in all instances. There are certain varieties which are superior from a wine-making standpoint but which are not suitable for dessert purposes.

SELECTION OF VARIETIES

Possibly it is of little value to analyse the variety question at any great length inasmuch as the Concord so completely overshadows all other varieties. While actual figures are, of course, not available, a careful estimate of grape plantings by varieties, made by an individual in close touch with the industry for some years past, is as follows:

Concord.....	67%
Niagara.....	12
Worden.....	8
Rogers'.....	7
Various.....	6
	100%

Thus the Concord is estimated to constitute two-thirds of the total acreage. That this estimate closely approximates the actual plantings is indicated by the following figures of sales of grapevines by the Ontario nurseries. (Statistics by courtesy of the Dominion Bureau of Statistics, Agricultural Branch, Ottawa).

TABLE III.
QUANTITY OF EACH VARIETY OF GRAPE VINES SOLD BY NURSERIES IN
ONTARIO DURING THE YEARS 1928-1937

VARIETY	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Agawam.....	1,526	.....	.....	1,506	1,036	1,110	1,783	1,601	8,696	11,019
Brighton.....	1,185	1,215	1,249	1,486	733	1,446	1,080	1,495	1,796	514
Campbell										
Early.....	6,438	6,701	3,032	4,040	1,874	4,462	8,523	3,690	3,872	3,849
Concord.....	358,647	506,970	478,895	315,823	84,447	40,932	71,921	66,235	37,073	68,416
Delaware.....	2,390	4,787	4,287	649	9,198	1,353	401	2,213	211	619
Fredonia.....	.....	.....	.....	.....	.....	.....	.....	.....	2,857	4,634
Lindley.....	1,064	590	576	1,584	1,121	1,362	1,210	832	1,146	1,252
Moore Early..	14,753	10,953	22,492	11,697	7,731	14,257	12,810	7,929	8,427	2,660
Niagara.....	138,300	141,878	130,738	101,984	76,903	49,266	62,947	44,898	32,828	50,338
Ontario.....	.....	.....	.....	.....	.....	.....	.....	.....	1,798	787
Patricia.....	.....	.....	.....	.....	.....	.....	.....	15,540	7,808	10,605
Portland.....	.....	.....	.....	.....	.....	.....	.....	5,739	1,411	3,550
Worden.....	52,769	49,666	35,277	24,135	8,503	13,094	18,231	9,400	8,126	6,438
Misc.....	19,312	20,732	368,154	18,586	10,694	12,982	28,593	5,571	6,054	6,470
	596,384	743,492	1,044,700	481,490	202,240	140,264	207,499	165,143	122,103	171,151

These figures, of course, are for recent plantings. They indicate a still higher proportion of Concords than the 67 per cent estimated, but the old-established vineyards probably contain a relatively higher proportion of varieties other than the Concord. This is indicated in that the planting of the Rogers' hybrids, for example, are known to have fallen off considerably in recent years. Also the estimate and the nursery figures are not strictly comparable as the latter give sales for only two Rogers' varieties, Agawam and Lindley, and further, do not take into account sales of miscellaneous varieties. Nevertheless, the preponderance of Concord is evident, with Niagara and Worden following far behind.



(Fig. 4) *Well-grown, one-year grape plants. Good nursery stock is the foundation for future profits.*

In discussing varieties, the ultimate purpose of the fruit, whether for dessert or wine, should be carefully considered. The variety question from the wine standpoint has already been briefly discussed in the section of the bulletin dealing with the wine industry. Further varietal discussion at this time will have reference primarily to fresh grapes for the market, and ostensibly to be used for dessert purposes.

While the Concord still dominates the fresh-fruit trade even as it does the wine industry, yet it is likely that new varieties will be introduced from time to time which will be more desirable for both dessert and wine purposes. If varieties can be originated which, while possessing adaptability to our

climate, have in addition something of the general quality, flesh-type and long-keeping characters of the "European" or "California" varieties, then it would seem possible to displace some of the imported product. There is an ample market here, too, as imported grapes for the calendar year 1936 amounted to over 25,439,896 pounds or almost half of the estimated Canadian grape yield. Some of our present varieties, such as Campbell, Lindley, Herbert, etc., possess European variety characters to a certain extent. Unfortunately, such varieties are inclined to fall short in other ways. Generally, however, it would seem desirable in future grape plantings to give more attention to better dessert varieties. Given the right type of native grape, the dessert market should be capable of very considerable expansion, partly at the expense of course of the present heavy imports.

It is recognized that some educational work will be required to bring about the above result, even when the right type of native American dessert grape is available. It must not be forgotten that the Canadian buying public up to the present has been "educated", insofar as native grapes are concerned, to the Concord and similar varieties with their more or less "foxy" odour and taste. The average purchaser has learned to expect this characteristic in native grapes; he has perhaps acquired a taste for it, and may not take any too kindly to native varieties of less pronounced "foxiness".

In the selection of varieties, roadside marketing should also be considered. A variety such as Brighton is of doubtful value where shipment to market is necessary. For local sale as from the roadside market however, its thin, easily-broken skin would not affect its sale. And its quality is such as to commend it to the most critical.

RECOMMENDED VARIETIES

WINE— Concord, Delaware, Dutchess (for trial), Lomanto, Niagara, Ontario, President (for trial).

MARKET— Agawam, Campbell Early, Concord, Delaware, Fredonia, Herbert, Niagara, Ontario, Patricia, Portland, Salem, Seneca.

ROADSIDE—Agawam, Brighton, Campbell Early, Concord, Delaware, Fredonia, Herbert, Niagara, Ontario, Patricia, Portland, Salem, Seneca.

Agawam (Rogers' 15). This is a red-fruited variety resulting from a cross of Carter or Mammoth Globe (red *Labrusca*) with Black Hamburg (*Vinifera*). Because of its self-fruitfulness, Agawam is probably the most

widely planted and popular Rogers' hybrid. It is vigorous, though subject to mildew, usually hardy, and moderately productive. Bunches and berries are large and attractive in appearance. In flavour it is rich, sweet, but decidedly foxy. It falls somewhat short in fruit characters in that the skin is thick and the pulp rather coarse and solid. The fruit keeps well in storage.

Brighton. This variety was originated by Jacob Moore, of Brighton, N.Y., from a cross of Diana Hamburg, a *Vinifera-Labrusca* hybrid, crossed with Concord, a pure *Labrusca*. Brighton is vigorous, productive, adapted to varying soil conditions, and for a *vinifera* hybrid, relatively resistant to fungi. In season it is considerably earlier than Concord. The bunches are attractive and larger than those of most native varieties. In quality it is excellent, being among the best, if not the best, of the varieties of native extraction. Unfortunately it deteriorates rapidly after picking, and, in addition, the skin is thin, easily broken, and the variety therefore not adapted to shipping. For local and roadside marketing it should find a ready and profitable sale. Being self-sterile it must be interplanted with other varieties.

Campbell Early. This variety was originated by Geo. W. Campbell, of Delaware, Ohio. It is a seedling of Moore Early pollinated by another production of Campbell's, a *Belvidere-Muscat Hamburg* seedling. It was introduced in 1892. Were it not for capriciousness as to soils, Campbell Early would be widely and deservedly popular as an early variety. Unfortunately it reaches perfection on light, deep soils only, and is therefore often referred to as a "sand" berry. When thus grown it has many fine qualities. In season it is ten days to two weeks in advance of Concord. The vine is hardy, vigorous and productive. The bunches and berries are large and attractive, blue-black in colour. The quality is excellent when mature, being free from foxiness and from acidity about the seeds. Because of the fact that it colours well in advance of maturity, it is often picked too early and its reputation suffers in consequence. The fruit keeps and ships well.

On the heavier soils, such as our grapes are usually planted on, Campbell Early is anything but satisfactory. On the right soil however, deep and comparatively light, Campbell Early is an excellent early variety.

Concord. This variety was originated by E. W. Bull, of Concord, Mass., from the seed of a wild grape planted in 1843. It was introduced in 1854. The Concord is the most popular and widely grown grape in Ontario, constituting close to 70 per cent of the total acreage. The outstanding character, which has given to the variety its present popularity, is its adaptability to varying soils and climatic conditions. It is everywhere productive, irrespective of soil type.

Though not high in quality, and possessing a foxy taste, Concord is well liked as a table grape. The fruit is an attractive blue with heavy bloom; bunches are of good size, regular and well-filled. Concord, which is a pure *Labrusca*, does not ship or keep well as compared with varieties possessing *Vinifera* blood, such as Campbell Early, Agawam, Herbert, etc. It is inclined to shell rather badly if held for any length of time. The place occupied by the Concord in the production of wine has already been noted.

Delaware, a red grape, is well known to both grower and consumer. In quality it is without equal amongst our native varieties, equalling the *vinifera* or old world varieties in fact. Because of this it justly commands a premium as a dessert grape on most markets. Delaware falls short in vigour of vine, yield, and size of bunch and berry. Vigour and yield can be offset largely by close planting, but the small size of bunch and berry must always count against the variety. In addition, the foliage is quite susceptible to mildew. Another difficulty is that birds are very partial to the clear-skinned, attractive, high quality fruit, with the result that all exposed bunches are likely to be so badly damaged as to entirely prevent their sale. As a wine grape Delaware has been widely used and much sought by wine-makers. Whether for wine or for dessert, the variety, if it be successfully grown, must have more than ordinary care and attention. Requisites are: a deep, rich, well-drained soil, close planting, thorough cultivation and relatively heavy pruning.

Fredonia. This variety, a black grape, originated from a cross of Champion x Lucile. It is better than either parent as an early variety, ripening fully a week earlier than Moore Early. Compared with Moore Early, Fredonia is more attractive both in size and colour, and of better quality, being little if any below Worden in this respect. The skin of Fredonia is tough, suggesting that it will prove a good shipper. The fruit keeps well on or off the vine. In vine characters Fredonia is superior to Moore Early, being vigorous and productive.

Herbert (Rogers' 44) is a sister seedling to Agawam, arising from the same cross made by E. S. Rogers in 1851. Of the "Black Rogers", Herbert is probably the best. When well-grown and properly mature it is hardly surpassed in quality among varieties derived, in part at least, from our native species. Considering all things, hardiness, vigour, early season, large size and handsome appearance of fruit, keeping and dessert qualities, Herbert is probably the finest table grape so far evolved in the amelioration of our native grapes. As with most black grapes, the fruit colours somewhat in advance of maturity, and when thus picked there is an astringency that wholly disappears with proper maturity. The variety keeps excellently for many weeks in ordinary cool cellar storage. The Herbert has not the sweetness, perhaps, of *Vinifera* or "California" varieties, but it has a sprightliness with its richness of flavour

which does not cloy the appetite as do the *Vinifera* varieties. As previously indicated Herbert is self-unfruitful, and therefore requires interplanting with good pollinating varieties such as Concord and Niagara.

Lomanto. This is one of the many Munson varieties introduced from Texas. The berry is black, small to medium in size, with a long, narrow bunch. Lomanto is hardy in the Niagara District and produces excellent vigorous vines. The leaves are dark green and are set off by the red colour of the wood and the black colour of the grapes. The variety is used for wine purposes only and produces a very dark red wine of good quality. The yield of this variety is very good, about on a par with Concord.

Niagara. This variety, a seedling of Concord, was introduced in 1882 by the Niagara Grape Company. Due to the advertising given the variety, and the method of dissemination whereby the above Company retained control of the stock for many years after its introduction, Niagara jumped into immediate popularity. This advertising, which subsequently proved to be over-advertising, counted against the variety in the long run. Nevertheless, it is our most popular and widely grown white grape. It would probably be more popular if it were allowed to ripen properly before being picked. The vine is vigorous, moderately hardy, as productive as Concord but more subject to disease. The bunches are large, surpassing Concord in this respect, and well-filled, almost too well-filled in fact, being so tight and unyielding that individual berries are easily crushed in handling. In flavour Niagara possesses the typical *Labrusca* foxiness, liked by some and not by others. As with any variety of grape, it must be fully mature before its full flavour is developed. Then it is good in quality.

Ontario is a cross between Winchell and Diamond, comes in season with Fredonia, and a day or two ahead of the variety Moore Early. Bunches and berries are larger and more attractive than either of its parents, but the bunches are not as compact. The vines are both vigorous and productive. The quality of the fruit is good. The grapes hang on the vines long after ripening. This green grape is recommended for all purposes, being both a good dessert and wine grape. It is probably not as well suited to light soils as to normal or heavy, grape soils.

Patricia. Originated with Wm. Baccus of St. Catharines, Ontario. It has been under test at Vineland since 1915, and gives promise of being a valuable addition to the early blue varieties. Patricia matures with or just after Moore Early, but is much superior to that well-known variety in vine characters. It is healthy, vigorous and productive. The bunches are large and of medium compactness. Quality is fair to good though the flesh is somewhat pulpy.

Portland. Ontario, described above, takes first rank as an early green grape for home use, but Portland, ripening at about the same time, holds first place among the grapes as an early green variety for the market. Also it is probably better suited to light soils than is Ontario. The vine in this variety is particularly satisfactory, as it is very vigorous, hardy, productive and healthy. The variety is remarkable for its luxuriant and persistent foliage. The quality is better than that of any other native green grape excepting perhaps Ontario.

Salem (Rogers' 22). Salem is another self-unfruitful variety. It must therefore be interplanted with a good pollinating variety. The berry is large and red, the bunch is medium to large and compact, and the quality is excellent. Salem is a sister hybrid of Agawam and Herbert, the parents of all three being Carter and Black Hamburg. Of the Salem, Hedrick, in "Grapes of New York" writes as follows: "Taking all of its characters, the variety is as close an approximation to the ideal Rogers had in mind of an European grape and an American vine as any one of the score or more of his hybrids. Salem ranks among the best of these hybrids for either the garden or the commercial vineyard, and while commonly found in both it has not been sufficiently recognized by those who grow grapes for the market. It is difficult to say why it is not more largely grown as a market fruit in New York. The two chief faults, unproductiveness and susceptibility to mildew, are not found in all localities, and in these at least and especially near good markets, Salem ought to take high rank as a commercial fruit."

Seneca. This variety is a hybrid between the Labrusca and Vinifera types of grape. Being almost pure Vinifera, it has many of the characteristics of this type. The grape is green, slightly oval in shape on medium-sized bunches. The texture of the flesh is firm, yet tender, and seeds easily. The flavour is sweet, vinous and slightly aromatic. The vine is vigorous, healthy, productive and hardy. This variety ripens with Pearl of Casaba, another Vinifera hybrid, and is the first grape to ripen in the Niagara District. Its season is about the 15th of September. Like most early fruits this variety is very attractive to birds, and considerable loss will result if not protected in some way. For early market and roadside stands it is recommended for trial.

POLLINATION

In the above lists there are three varieties which are often called "Rogers' Hybrids". These are Agawam (Rogers' 15), Herbert (Rogers' 44), and Salem (Rogers' 22). Of these three, Agawam is self-fertile or self-fruitful, so that it may be planted without reference to cross-pollination. Herbert and Salem, however, and also Brighton, are **self-unfruitful**. Therefore, in planting,

provision must be made to include with them good pollinators such as Concord and Niagara, or in fact any of the other varieties recommended, all of which with the exceptions noted are self-fruitful and good pollinators. Brighton apparently is easily cross-pollinated as it almost invariably sets good crops of large, well-filled bunches. Herbert is not so easily pollinated as, even where ample provision has been made for cross-pollination, the bunches are apt to be straggly and the yield light.



(Fig. 5) Proper interplanting of the self-sterile varieties with any good pollinating variety increases the size of the crop. (Right) Flower cluster from a self-sterile variety completely failing to set fruit through lack of pollination. (Centre) The result of partial pollination. (Left) The result of good pollination.

LOCATION AND SITE

Examination of the table of acreages by counties previously given, indicates that the grape centres are largely in those sections which come under the influence either of Lake Ontario or Lake Erie. It is evident that for the best varieties and for commercial culture some protection from extreme cold is necessary. Grapes, however, thrive fairly well without winter protection in the greater part of Western Ontario, though favouring proximity to large bodies of water.

Before taking up the somewhat narrower question of site there should be some discussion of the more general subject of location. Location is of extreme importance. In the Niagara Peninsula, wherein is grown the bulk of Ontario's grapes, the general aspect is north facing the waters of Lake Ontario with the so-called "mountain" or escarpment in the rear. There the crop naturally varies but never entirely fails. The favoured spots in this general location are not on the shore of the lake, but rather just below and on the first bench of the escarpment where the water has less influence. In vineyards close to the lake the fruit sometimes fails to ripen well, with consequent inferior quality. If the volume of water were smaller, the influence would be sufficient for frost protection only. As it is however, it retards development in the spring and further prolongs the period from the commencement of growth in the spring to maturity of fruit in the fall, owing to its cooling effect during the summer months. Depending on the direction of air currents, there is often a difference of several degrees in temperature. This water influence is striking on other fruits as well as grapes. Peaches, for example, often ripen a week later on the shore than two to four miles inland. In seasons such as that of 1926 when even the most favourably situated vineyards barely matured their crops, delayed maturity becomes a matter of the utmost concern.

There are, of course, several factors which are conducive to late maturity of the fruit. Those which have to do with soil types will be considered in the discussion on soils. Where the short growing season is a normal climatic condition it cannot be overcome except by planting earlier maturing varieties. In other cases, where it is due to abnormal weather conditions such as obtained in 1926, it cannot be overcome by such direct means. The sowing of a quick-growing green crop, such as oats, may assist, but ceasing cultivation and allowing the weeds to grow and the canes to ripen is often all that need be done.

The particular site is of importance for several reasons, chief among which are air-circulation and natural soil drainage. Good air-circulation, and of course sunlight, assist the grower in his fight against disease. Then as to soil drainage little need be said, other than to emphasize that a warm, dry, deep soil is essential to early maturity and high quality.

The danger from early frosts in the fall is largely one of site. Low-lying, flat land suffers first. Cold air settles in such situations, while more elevated or rolling sites are always more or less affected by air currents. Cool air flows down and away from them, making them relatively frost-free.

SOILS

Confining discussion to the commercial areas, we find that grapes are successfully grown on a great variety of soils under varied conditions. Good

vineyards are to be found on the clay soils of Vinemount, Beamsville and St. Catharines, the mountain wash of Winona, the black muck of Homer, the sandy loams of Jordan, Vineland and Port Dalhousie, the sand of Fonthill and the gravel in the Burlington district. Nevertheless, certain general soil preferences should be noted. Also individual varieties have soil preferences as indicated in the variety discussion.

Site has been shown to influence date of maturity. A cold soil is often a main cause of slow or delayed maturity. Coldness is largely due to the water content of the soil. Grapes thrive best on the warmer, drier soils where the fruit matures earlier with consequent higher sugar content and quality. A moist, cool sand, ideal for strawberries and raspberries, often fails to properly mature the grape, and even in favourable seasons does not give as high a sugar content as the heavier soils. On the other hand the harder, heavier clays ripen the grapes early as a rule. An exception, the Fonthill sand, will be noted later. Under-drainage will make the cool sands warmer, but the undertaking is considered inadvisable as these soils are more valuable when planted to small fruits.

Two types of soil give large crops of high quality grapes. These are the silty soils found below the escarpment in the Niagara Peninsula, and the soils of the first ledge of the escarpment mapped in the soil survey work as Dunkirk clay loam. The former is of a grey or black colour and from six to nine inches deep, underlaid with a heavy subsoil of bluish or drab coloured clay. Where the proportion of organic matter is greatest, the soil is darkest and most open and friable. This type of soil is derived from glacial lake deposits and occupies low-lying areas. The Dunkirk soil is dark brown to greyish brown clay and clay loam, about eight inches in depth, somewhat hard and cracks on drying. Owing to its nature it is usually easy of drainage, but the subsoil is hard and impervious to water. The grit and gravel, well mixed with the greater part of this soil, tend to keep it more loose and open than it otherwise would be. The exception to these two types of grape soils is found in the warm, drier sands such as are found in the Fonthill district and scattered in various other parts of the grape-growing areas.

A part of the grape soils of New York State are of this nature. Warmer, drier, natural conditions, tend to early ripening and good quality. The yield is possibly somewhat lower, but the warmth is an insurance against non-maturity.

In Michigan also, grapes do best on loams, sandy loams or sand, but here again the soil type is more like that of the Fonthill area. In Michigan, according to Bulletin 121, Grape Production in Michigan, "The heavy types of soil cause a very heavy vine growth and later ripening of fruit. This is a

disadvantage in years with early fall freezes. On the other hand, the heavy soils produce a heavier tonnage of grapes than do the lighter soils. The very sandy soils produce vines of poor vigour and consequent lower fruit yields. Grapes mature earlier, however, when grown on the lighter soils."

The difference in maturity, etc., under Michigan soil conditions, as compared with Niagara Peninsula conditions is best shown by reference to grape maturity tests made by the Horticultural Experiment Station in 1916 and 1917. For the purpose of these tests, fruit was secured from every grape area between Burlington and the Niagara River, and from the various soil types. Repeated visits were made to selected vineyards during the ripening season so that the maturity of the varieties under test could be traced. Also, in as far as possible, all districts were visited within a two-day period so that the development on the various soils might be fairly compared.

The results obtained confirm the statements already made with reference to maturity of grapes on Ontario soils. Grapes grown on the heavier soils matured earlier than those grown on the lighter soils. This was particularly noticeable in 1917 when all grapes were late in maturing. Only those on heavier soils were really fit for marketing when the early frosts came. Further, it should be noted that increased elevation tended to overcome soil influence. Thus Vineland clay, unlike most other clay soils, produced a slow maturing grape. In both years, 1916 and 1917, the muck soil of Homer produced the highest quality fruit.

PLANTING

Preparation of the Soil

As for all our commonly grown fruits, thorough preparation of the soil before planting is advisable. It is poor practice to set vines in sod land plowed the previous fall. If grapes must be set on old sod land it should be summer fallowed the fall preceding planting, and plowed again in the spring at the time of planting. To thoroughly prepare and clean land for grapes it is best to grow some hoe or grain crop the year before planting. Then, as soon as the land is dry enough in the spring, it should be well worked with a disc and spring tooth cultivator.

Distance of Planting

Distances of planting vary very much throughout the grape district. They range from 12'x10' and 10'x10' to as close as 8'x8' and 8'x7'. These differences are due to variations in the soil, and variations in the vigour of the varieties of grapes. Vines planted on the lighter, sandy soils, require more



(Fig. 6) *Maintaining soil fertility by plowing down a heavy green manure crop of Japanese millet.*

feeding space than the same varieties planted on clay or clay loam. Such varieties as the Niagara and Lindley are far more vigorous, requiring longer pruning than Delaware, for example; and hence must be farther apart in the rows than this variety.

The distance between the rows has been practically fixed to nine or ten feet, the smallest space in which a wagon can pass conveniently down the rows to gather the fruit, or in which a tractor can operate to advantage.

For the standard varieties as Concord, Niagara, Vergennes, Worden and the Rogers' varieties, a space of nine and a half to ten feet between the rows and nine feet in the rows is recommended. For the less vigorous, smaller growing varieties such as Delaware, a space of nine and a half to ten feet between the rows and seven or eight feet in the row is sufficient on average grape soil.

NURSERY STOCK

Well-grown, one-year-old nursery stock is to be preferred to two-year-old plants, as they usually show better vigour. As a general rule two-year plants are the weaker one-year plants grown in the nursery for the second year.

Very frequently the grower does not place enough importance on the selection of first-class stock. To many the lower price of the poorer grade appeals strongly. Nevertheless, in purchasing vines it must be borne in mind that the young vines are the foundation stock upon which the vineyard is to be built; and, if poor vines are planted, the vineyard will be handicapped right from the start.

Immediately on receiving the vines from a nursery the bundles should be opened, the vines spread out, and heeled-in in some sheltered spot. The earth should be well mounded up to the vines, and care taken not to mix the varieties.

PLANTING THE VINE

Vines may be planted in the late fall or the early spring with equally good results. If planted in the spring, the earlier the vines are set the better, because this enables them to become well established in the soil before the heat of the summer comes on.

The young vines must be pruned before planting. If the vine has several canes, all but one should be removed, and this one should be shortened to two buds, although for convenience in planting this cane may be left until the vine is set. This pruning makes the vine less liable to dry out before rooting, and forces the growth from the lower buds which produce more vigorous shoots. The roots should also be thinned and cut back to about nine inches.

Previous to planting, the vineyard must be staked to show the location of the rows. Needless to say, care must be experienced in making these rows straight as the ease of all subsequent vineyard practices depends upon this. To facilitate striking a straight furrow in which to set the vines, stakes may be set at frequent intervals along these rows. As deep a furrow as possible is made the first time, and then by returning in the same furrow it can be made about ten to twelve inches deep, which is sufficient for the vines. Where the soil is shallow, it may be necessary to dig all holes, using the plow for marking only.

As soon as the furrow is made, planting should be begun and should follow up the plow all the time. A rod cut to a length equal to the distance apart of the vines in the row may conveniently be used to show the position of the vines. One man usually does the planting, but in case of large plantings two men are often used and a boy supplies them with vines which have already been pruned.

In planting, the roots of the vine should be spread out carefully, and the ground firmly tramped over them and beyond them to a distance of eighteen inches. The vines must be set so that the two buds left on the cane are just above the ground. If the vines are set deep enough, the roots spread out, and the soil well firmed over them, the grower can count on most of his vines growing.

Rather than plant in furrows as mentioned above, many growers prefer to plant in dug holes, in this way obtaining more room for the roots which can then be spread out to better advantage.

CARE OF THE VINEYARD

The only attention the newly set vineyard requires during the first season is thorough cultivation. This may be given most economically in conjunction with a companion crop or intercrop requiring clean cultivation, such as early potatoes, sweet corn, tomatoes, etc.

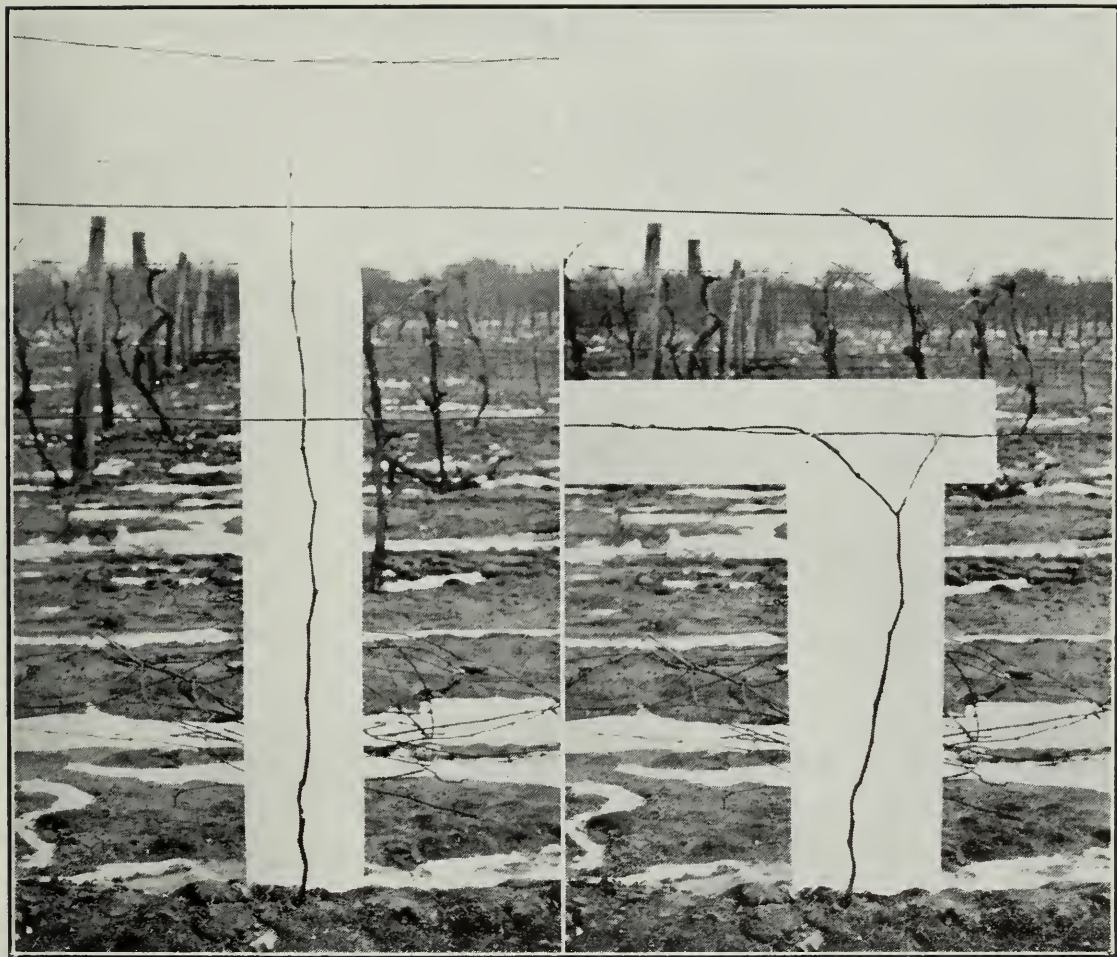
If the vines make good growth in their first year, it is well to set the trellis in the fall so that the vines may be trained up to the wires the following spring. If growth has been poor, trellising may be delayed a year, in which case the vines should be pruned back uniformly to one cane of two or three buds. Many growers practise pruning back in this way at the end of the first season's growth, irrespective of the amount of growth the vines have made. However, experimental work has shown that where good growth has been made there is nothing gained by delaying trellising. In fact fruiting is delayed and without any compensating benefit to the young vine. Train those vines which have made sufficient growth to the top wire, tying the plant as high as it will go and as straight as possible. With those of lesser vigour some may permit of training to the lower wire, while others will need to be cut back to a single cane of two or three buds as already indicated.

In training the young canes to the wires, only one cane of course, the most vigorous and desirable, should be left on each plant. This should be cut off just above the upper or lower wire as the case may be. The canes should be straightened out and tied tightly to the wire to keep them taut, thus developing good straight trunks. With weak vines which had to be cut back to 2-3 buds, all but one of the new shoots which start to grow, should be removed early and this shoot should be tied to the trellis as soon as it is long enough.

During the second season's growth it is advisable to remove all suckers and secondary shoots which may be produced below the first wire. This will encourage growth on the upper part of the vine. If this is done carefully the grower will rarely be troubled with suckers in later years. After the third

season's growth the vine is pruned to suit the system of training which is to be followed; and from then on it is treated as a mature vine. In the above discussion it has been assumed that the Kniffen system of training is being followed.

The mulching of young vines late in the fall with straw or strawy manure is a practice to be recommended. The mulch not only serves as a protection but, when plowed under in the spring, improves the physical condition of the soil.



(Fig. 7) Correct (left), and incorrect (right) method of tying the young plant after the first season's growth. In order to obtain a straight trunk, tie the selected cane full length to the highest wire it will reach. Heavy heading back at this time delays fruiting and accomplishes no useful purpose.

TRELLISING

Posts and Bracing

Well cured cedar posts are preferred by most growers, though the creosoted post is coming into favour. The creosoted post lasts longer than the

cedar and in consequence somewhat lighter posts may be used. If cedar is used, the end posts should be at least five inches in diameter and eight and one-half feet long, the intermediate posts three inches in diameter and seven and one-half to eight feet long. The posts should be set approximately thirty feet apart in the row, depending on the planting distance of the vines, and, in the case of the intermediate posts, should extend into the ground two and one-half to three feet.

There are many methods of setting and supporting the end posts. In any case the end post must be set from four to four and a half feet deep to enable it to withstand heaving, and to support the weight of the vines and fruit. Perhaps the oldest method is that of bracing the end post with a rail or scantling from another post set about eight feet away in the row. The brace should reach from a point about a foot above the ground on the second post to within eighteen inches of the top of the end post. To complete the bracing a guy must be passed from about six inches below the top of the second post to a short distance from the ground on the end post. This method is one of the strongest and most satisfactory. The high cost of scantling for braces and also the cost of an extra post are the factors which are against its more general use.

Another method which is being much used because of its low cost is that of guying the end post. The post is set in a hole at a slight angle. Some large, heavy stones may be placed in the bottom and the rest of the hole filled and packed with soil. The post is then guyed with a strong galvanized wire, one end of which is fastened to the post one foot from the top and the other end to a stone, or short post buried three and a half to four feet in the soil and from four to five feet from the post, which is as near to the post as it is possible to get without decreasing its purchase. Besides the small original cost of setting these guys they furnish strong support to the posts while they last. The wires, however, are a nuisance in cultivating. The implements will not only often hitch into them, sometimes breaking them off, but the wires are bound to rust and break, and it is hard and expensive to replace them. Another point is that the headlands of the vineyard are much more difficult to keep clean when this method of supporting the end posts is used, than when they are braced or set in cement.

WIRING

Before wiring the graperies it must first be decided whether four or six arms are to be used in training the plant. At the present time the majority of the older graperies have two wires, the plants being trained to the four-cane Kniffen system. Some growers prefer the six-cane system in that it spreads the growth over a larger area, thus making most cultural practices such as

pruning, spraying, and cutting of the fruit somewhat easier. Then there is also the advantage that in unfavourable seasons more of the vine is spread out to the wind and sunshine, lessening disease and hastening ripening.

No. 9 galvanized wire is the proper size to use. A lighter wire gives way too soon. In a two-wire system the first wire is placed at thirty inches above the ground, and the second twenty-four to thirty inches above the first. If three wires are used, the first wire should be at least twenty-four inches above the ground and the other two at eighteen-inch intervals above the first wire.



(Fig. 8) *Four methods of bracing the end posts. (1) Guy wire on straight end post. (2) Guy wire on slanting end post. (3) Short scantling brace. (4) Long scantling brace between end post and special second post. Notice the guy wire in each case. Method No. 3 is to be preferred, but is the most expensive.*

Wiring a vineyard may be done very quickly. Quarter-inch holes are bored in the end posts, the same direction as the wire is to be strung, and at the distances the wires are to be above the ground. When the wire is stretched along the row, the ends are passed through the holes in each end post and made fast to the wire tightener. While a proper wire tightener with block and pulley is the most satisfactory, yet many simple devices may be used for tightening



(Fig. 9) Four methods of wire tightening. (1) $\frac{1}{2}$ -inch bent iron bar. (2) Large iron hook. (3) Square wooden block. (4) Iron reel. All four methods are good but No. 3 is the cheapest.

the wire. One of the most common is a block of hard wood, one and a half inches square and eight or nine inches long with a quarter inch hole bored through the middle of it. The wire is passed through the hole in the stick and made fast; then it is tightened by turning the block with a monkey wrench. The block is kept in place by its shape, together with the tautness of the wire.

Another method is to use a small iron reel on which to wind the wire after it passes through the hole in the post. Probably the commonest of all iron tighteners is the small, slightly curved iron bar about one-half inch in diameter. This can be wound up tight similar to the wood block.

When stapling the wires to the posts, space should be left to allow the free passage of the wire when it is slackened in the fall and tightened in the spring. Unless the wire is regularly slackened in the fall, it and the posts will be subjected to an undue strain when the already taut wire contracts with the cold weather. This strain will in time either loosen the posts or break the wire.

NUMBER OF FEET TO THE POUND OF DIFFERENT SIZED WIRE:

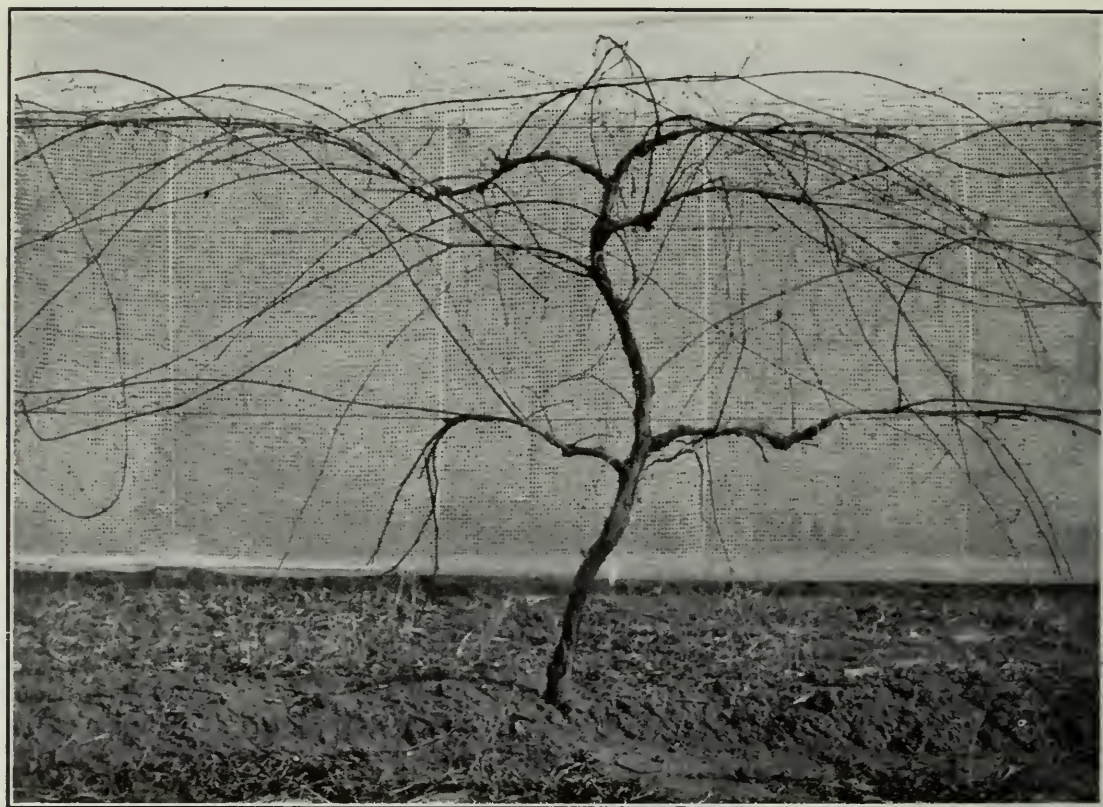
No. 9—	Feet to the pound.....	17.95
10—	“ “ “ “	22.33
11—	“ “ “ “	27.34
12—	“ “ “ “	34.29

PRUNING AND TRAINING

Training the Vine

Different grape growing sections often have preferences as to systems of training. In the Niagara district many systems may be found such as Fan Arm or Horizontal Arm, four and six-cane Kniffen, Improved Kniffen, and “go as you please”. There seems to be a growing sentiment in favour of the four and six-cane or ordinary Kniffen, though possibly no one system has any distinct advantage over another. The main advantage of any system is that it is a **system** with consequent uniformity of work and appearance, and simplified handling in vineyard operations, particularly pruning.

The Kniffen system is shown in the accompanying illustrations and needs no further description. The Kniffen and the Fan are the most commonly used systems in the Niagara district.



(Fig. 10) Very vigorous Concord vine before and after pruning. Weight of wood removed was $4\frac{1}{2}$ lbs. Vine was pruned to 60 buds. Note that in Figs. 10, 11 and 12 the weaker the vine, the fewer buds should be left.

PRUNING

The training and pruning of the young vine have already been discussed in the section dealing with "The Care of the Young Vineyard". The present discussion concerns the mature bearing vine.

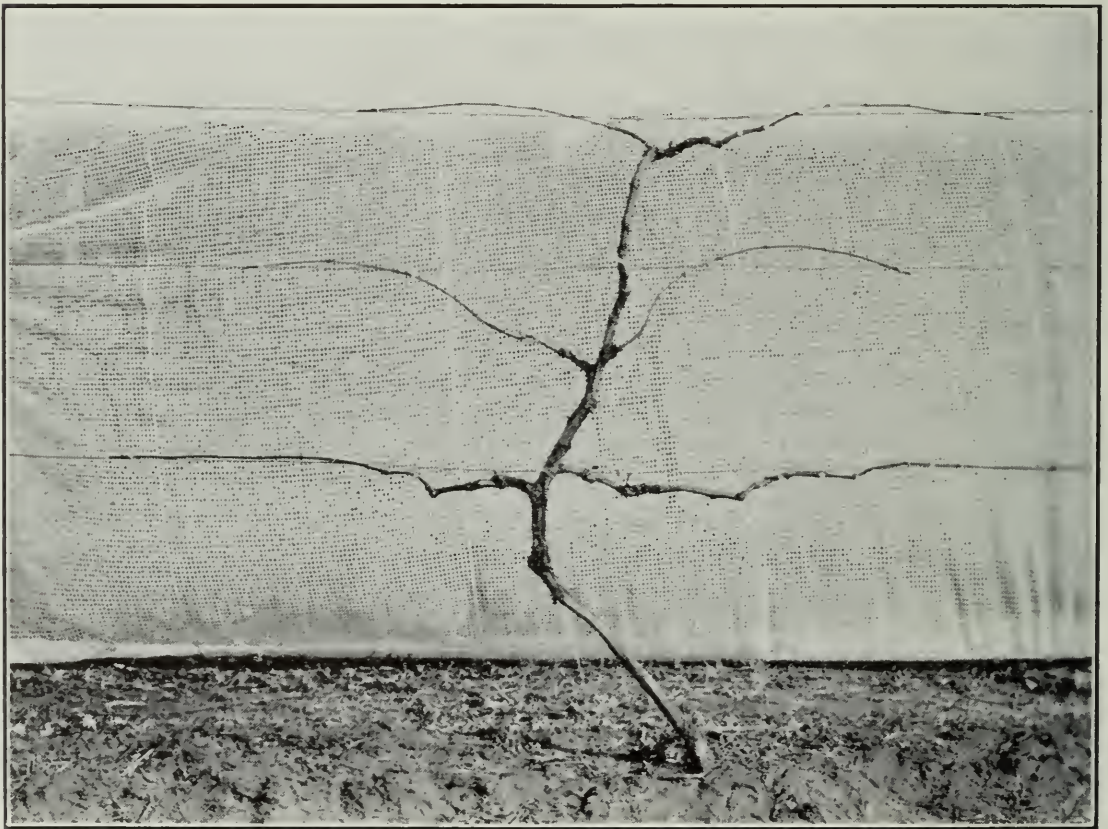
Time of Pruning. Pruning may be done any time after the leaves have fallen from the vines until the vines begin to "bleed" in the spring. The main thing is that the vines be thoroughly dormant. The usual practice throughout the Province is to do most of the pruning during the months of January, February and March. Any time during these months will be quite satisfactory except on very cold days, when the vines are very brittle from heavy freezing. The usual plan in the Niagara District is to prune the grapes first during the winter months, leaving the peaches till the warmer days of early spring.

Number of Buds per Vine. The objects of pruning are to restrict the growth of the vine sufficiently to enable it to produce the maximum quantity and quality of fruit year after year without impairing the vigour of the vine; to economize in space; and to facilitate vineyard operations such as cultivation, spraying and harvesting.

The amount of wood or the number of buds to be left per vine will vary with the variety and the vigour of the individual vine. Generally speaking, the greater the vigour, the more buds can safely be left. In other words, individual grape vines should be pruned in accordance with their capacity to produce fruit. This capacity may vary from season to season with individual vines, depending upon seasonal weather conditions, varying soil fertility, amount of previous crop, etc.

It is evident then that no hard and fast rule can be laid down stating that so many buds, say forty, should be left for all varieties under all conditions. Rather, individual growers will have to determine the optimum number for their particular conditions, varying this number to some extent with occasional vines which are above or below normal in vigour. For Concord, a general rule of thirty-six to forty-eight buds per vine may be laid down.

In addition to leaving the four or six regular fruiting canes, it is often advisable to leave additional short two-bud canes from which new vigorous canes close to the main trunk may be secured the following season. The function of such "spurs" is of course to provide a renewal of fruiting wood close to the trunk, and it is therefore unnecessary to leave such spurs where the arms are already short.



(Fig. 11) Moderately vigorous Concord vine before and after pruning. Weight of wood removed was $2\frac{1}{2}$ lbs. Vine was pruned to 42 lbs.

Date of maturity of the fruit is influenced by size of crop. This is an important point in the Niagara District, especially for those growers whose vineyards are naturally inclined to be late in maturing. Vineyards close to the lake, for example, would fall in this class. In a general way it may be stated that the greater the crop the later the maturity. It is obvious, therefore, that the grower who habitually suffers from too late maturity should practise more severe pruning. In his case the optimum number of buds is determined by date of maturity rather than by the quantity of fruit that the vine can support year after year without noticeable impairment of vigour.

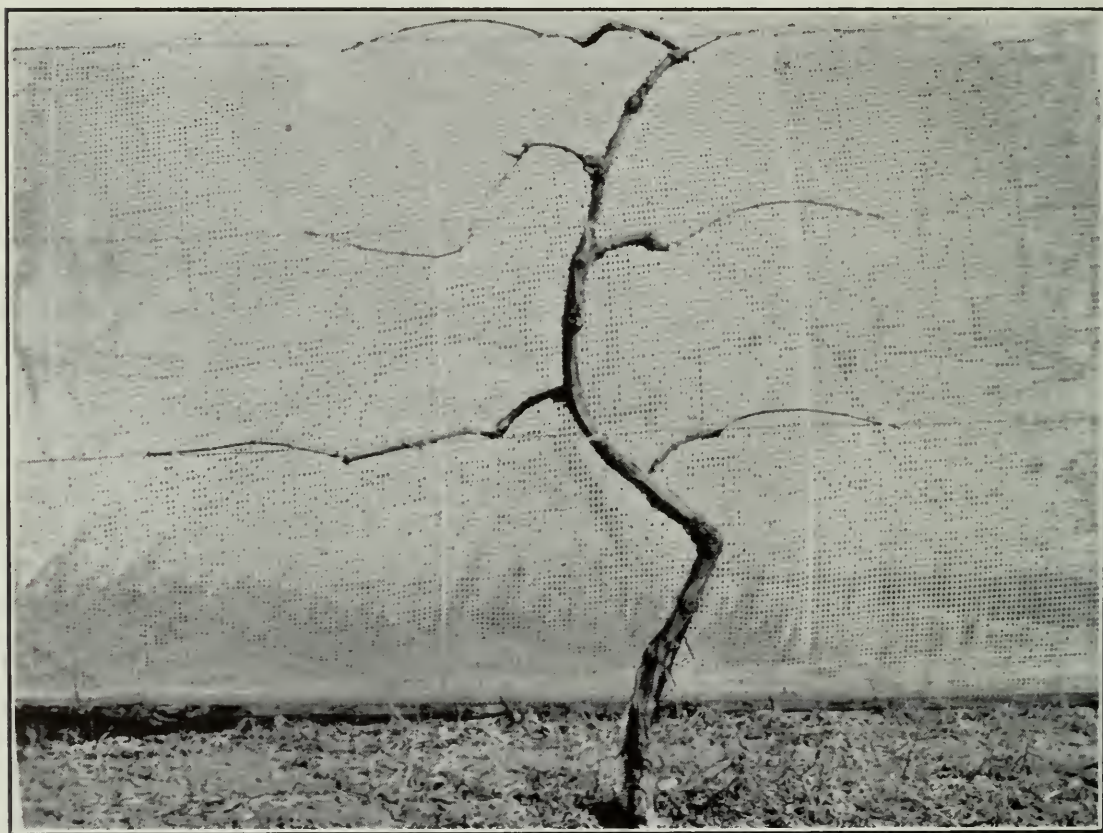
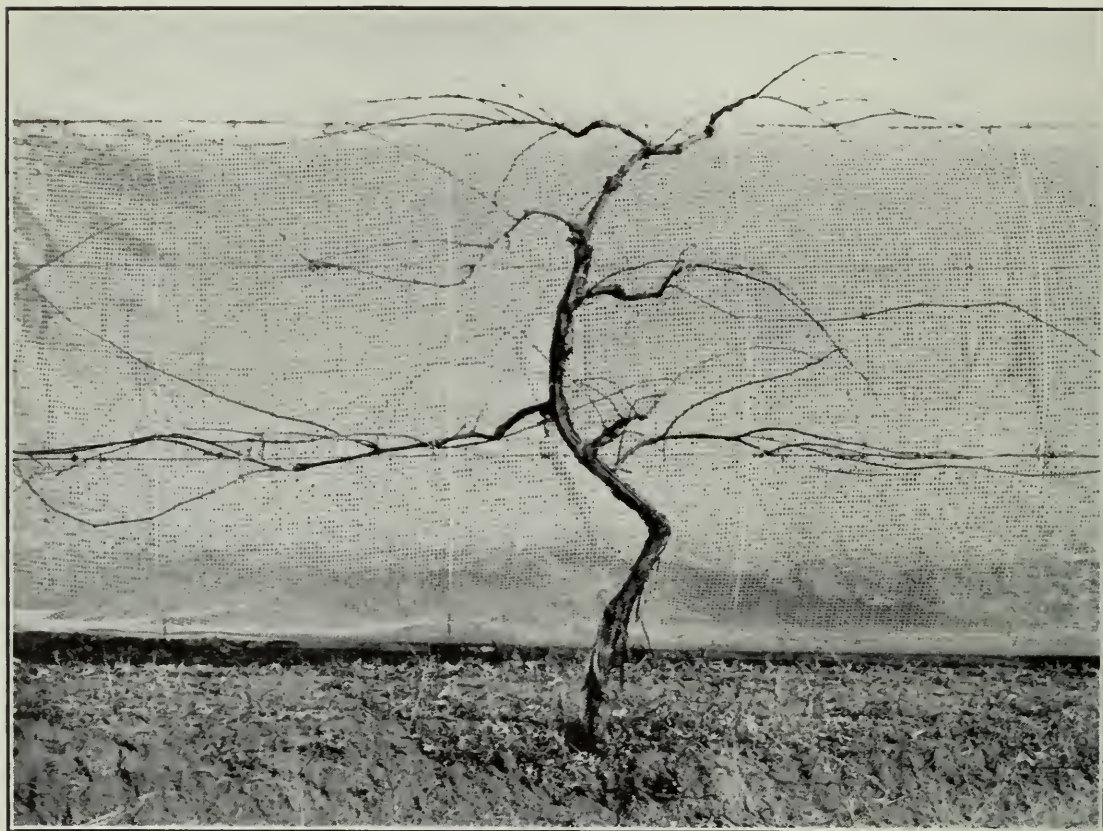
Relation of Cane Diameter to Fruitfulness. The so-called “bull” canes are generally considered unproductive and undesirable. The correctness of these conclusions is indicated in experimental data obtained by N. L. Partridge, of Michigan. These data show that the medium or pencil-size canes of approximately one-quarter inch diameter are the most fruitful. An increase or decrease from this size is accompanied by decreased fruitfulness in both cases, the amount of decrease being roughly proportional to the deviation from the optimum size—one-quarter inch. Where canes of the right diameter are unobtainable, those slightly above the quarter-inch are to be preferred to those falling below this diameter. In addition, canes of moderate length between joints are to be preferred to short-jointed canes.

Some Varietal Differences in Relation to Bud Number. As already intimated the optimum number of buds per vine to be kept in pruning will vary to some extent with the variety. For several years an experiment was conducted in the Station vineyard to study varietal differences in this respect. The results of these observations are given herewith.

The optimum number of buds per vine as judged by maturity of fruit, unimpaired vigour of vine, and continuous yield for the six-year period, 1918-23, varied from twenty-eight to forty-eight for the ten varieties under observation. The accompanying table gives the results in brief:

OPTIMUM NUMBER OF BUDS PER VINE FOR STATION VINEYARD

VARIETY	NO. OF BUDS
Vergennes.....	28
Brighton.....	32
Concord.....	36
Delaware.....	36
Diamond.....	36
Herbert.....	40
Lindley.....	40
Niagara.....	40
Agawam.....	44
Massasoit.....	44



(Fig. 12) Weak Concord vine before and after pruning. Weight of wood removed was 1 lb.
Vine was pruned to 30 buds.

Most if not all of the above varieties will give as good yields, and sometimes higher, where the number of buds exceeds by four or more the optimum number noted. However, time and evenness of maturity must be considered. Also it follows that where an increase in number of buds (with its increased number of bunches) does not give a proportionate increase in yield, the berries and bunches on the higher bud-number vines must be of inferior size. Nothing, therefore, has been gained by increasing the bud number, and much may be lost by delayed maturity, etc.

The twenty-eight buds noted for Vergennes may seem low. Vergennes is a notorious overbearer, and if insufficiently pruned, the fruit will fail to colour or mature properly and the vines will fall away in vigour.

With Concord, forty buds may be left on vines of normal vigour, rather than the thirty-six noted, provided that the particular vineyard does not habitually suffer from late maturity due to location or some other factor. The same reasoning holds for many other varieties, including Niagara and Herbert. Nevertheless, as already indicated, improper maturity is so often a factor in the Niagara District as a whole, that the grower should err on the side of too few rather than too many buds.

Delaware canes are short-jointed. With this variety, number of buds should not be estimated by length of cane alone but by frequent count, otherwise far too many buds will be left by the average pruner.

The Rogers' hybrids, such as Agawam and Massasoit, are very vigorous growers and, apart from other considerations, a relatively large number of buds must be left or growth will be too rampant and of the "bull cane" type. Also Lindley, Agawam and Massasoit normally mature early so that this factor does not need the same consideration. Herbert is later in season and does require consideration.

RENEWING OLD VINES

It is sometimes necessary to renew old vines where the trunk has become crooked and bent and has perhaps deteriorated from disease. If the root is healthy, such renewal can usually be effected by bringing a new lateral from near the ground. The old trunk may be removed at once, or may be left to fruit for one or two seasons until the new cane is ready to take its place.

TYING THE VINE

Following the dormant pruning and the tightening of the trellis wires in the spring, tying is the next vineyard operation. Tying should not be done

when the canes are frozen as they are then quite brittle and easily broken. Nor can tying be delayed until after growth starts because of the danger of rubbing off the new growth.

Both grape twine and fine wire are used for tying, though most growers prefer the twine. The twine is the better material of the two, though when carefully used, wire gives quite satisfactory results. Wire cannot be used to secure the trunk and main arms of the vine to the trellis because of the danger of girdling the vines.

The trunk should be tied tightly to the wires in an upright, straight manner. Sagging, crooked trunks interfere with many vineyard operations. Before tying the canes (Kniffen system) it is a common practice to give the cane one or two twists around the wire. This secures the vine more firmly to the trellis than merely stretching the cane along the wire. However, such wrapped canes materially increase the difficulty of pruning the following season. In either case each cane should be tied twice, once at the tip, where a tight knot should be made, and once near the base, in this case a loose knot so that normal cane growth, without binding or girdling, may be made.

When tying with grape twine it is advisable to give the cord a couple of turns around the wire, knot it, and then tie the cane securely to the wire. This method prevents any slipping of the cord along the wire and, at the base of the cane, permits of a secure though loose tie, thus allowing for cane expansion.

It is false economy to hurry over the tying of the vines or to use material for tying which is not sufficiently strong or durable. This always results in much troublesome re-tying and often injured arms.

DISBUDDING

Disbudding is practised on young vines which have not yet formed a stem, in order to concentrate the growth into one or two shoots. The following year the stronger of these shoots will be selected to form the stem of the vine. In case of mature vines, disbudding consists in rubbing off all the buds on the lower part of the vine and particularly at the base of the trunk, which are not needed for renewal purposes. This is done in order to concentrate the growth in the shoots above and prevent the production of shoots down below the first wire, where they would eventually have to be cut off. These buds or young shoots should not be removed until they are from three to four inches long. Since there are many dormant and adventitious buds on the trunks of the vines, any attempt to remove the buds too early would force out fresh growth and necessitate going over the vineyard too often.

SUCKERING

Suckering is the removal of all the shoots which appear on the trunk of the vine at or below the surface of the soil. These suckers bear little or no fruit, and hence grow vigorously, appropriating food materials which should go to the vine. A great deal of time and expense will be saved if suckering is done carefully during the first four or five years of the vine's growth. After the fifth year very few suckers will be produced from vines which have been carefully suckered when they were young. Vines on which the work has been carelessly done will always produce an abundant growth of these underground shoots every year. Suckering should be done early in the summer before the shoots have become hard and woody, not only because of the fact that they diminish the vigour of the vine, but also because, if the shoots are left for the whole season, or for any length of time, they promote the production of dormant buds below the surface of the ground. These old suckers are more difficult to remove than are the young shoots, and if imperfectly removed, the remaining part becomes an underground spur which will be a perennial source of trouble.

SUMMER PRUNING

The removal of two or more feet from the end of growing shoots during the month of August is sometimes practised in the Niagara District. It is done to admit light to the fruit, thus increasing its colour, and also to control mildew by permitting a better circulation of air through the vine. Since this topping is done towards the latter part of the summer, a great number of leaves are removed, which is very weakening to the vine. In the case of very vigorous vines this may not be serious, but if severe topping is practised annually it is bound to weaken even the strongest vines.

In certain seasons when excessive growth is produced because of a prolonged rainy season, it may become necessary to resort to topping to admit sufficient light to colour the fruit or to check the spread of mildew, **but never in a normal season.** At least seven or eight leaves should be left beyond the fruit when topping in August. The grower should, however, be able to maintain the equilibrium of his vine by increasing or diminishing the amount of fruiting wood left during dormant pruning without having to resort to this weakening practice of topping.

VINEYARD SOIL MANAGEMENT

Cultivation

Frequent and thorough cultivation throughout the growing season is absolutely necessary for the best growth of the vines and the production of the crop. The first operation in the spring, as soon as the soil is dry enough to work, is to plow away from the vines. For this purpose a gang plow, which does the work more quickly and evenly than a single plow, is preferable. A furrow three inches deep is sufficient to turn over the surface soil and still not deep enough to disturb the surface roots of the vine. It is very important that roots of well-established vines should not be torn up or carelessly exposed by deep plowing. In some cases where the soil is friable and there is no cover crop to plow under, the disc may be used instead of the plow to loosen the soil in the spring. Many growers prefer this method. The grape hoe and hand hoe should now be used to work the soil away from the vines. Subsequent cultivation at least every two weeks during the summer should be given with the disc or spring-tooth harrow. Special care should be taken to cultivate before the soil has become caked and crusted after heavy rains.

All cultivation should be stopped by the 15th of July at the very latest to give the vines a chance to ripen their wood and fruit before freezing. In backward seasons it would be advisable to discontinue cultivation at least two weeks earlier. Fall plowing up to the vines may be done at this time, or preferably later, after the crop is off. The disadvantages of early fall plowing are: Some fruit may be torn from the vines by the plow or horses; the soil is left in too rough a condition for the pickers to walk and work quickly along the rows and for the wagon gathering the fruit to be driven over easily.

GREEN MANURE CROPS

Green manure crops should be used in the grapery wherever possible. Their functions are: To check growth in the fall, thus giving the vine time to properly mature its wood; to utilize nitrates available in the soil after the vine has ceased growth, and prevent their loss from leaching; to add nitrogen to the soil, when a leguminous plant is used; to hold the snow and thus prevent deep freezing; and, of great importance, to maintain or improve the humus content of the soil. Humus, because of its moisture-holding capacity, may be said to form the basis of soil fertility. The grape is a long-lived plant, and, unless the humus supply is replenished, most grape soils will eventually become deficient in their humus content. Barnyard manure, of course, is one of the best sources of humus and should be used whenever it can be economically secured. Where manure is not available in sufficient quantity, green manure crops will provide a very satisfactory substitute.



(Fig. 13) *Japanese Millet used as a green manuring crop. Planted July 1st.*

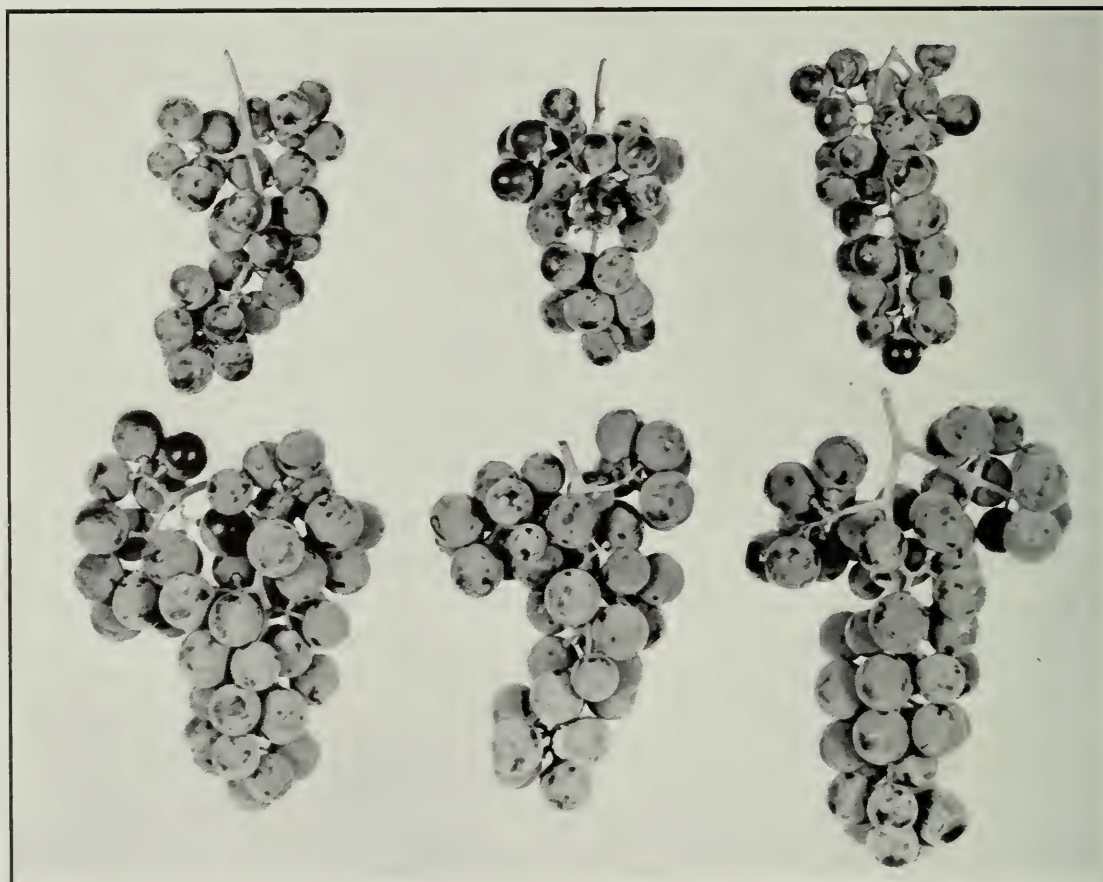
Some of the best green manure crops to use are: Oats ($1\frac{1}{4}$ bu. per acre), rye (1 bu.), oats and clover (1 bu.—15 lbs.), rye and vetch (1 bu.— $12\frac{1}{2}$ lbs.), Japanese millet (3 pecks). Oats and Japanese millet both make a strong growth in the fall and are therefore somewhat objectionable at picking time. On the other hand both are winter-killed, and there is therefore no temptation to delay spring plowing as in the case of rye and the clovers, which make heavy growth in the spring. It is essential that spring plowing be done early. Delayed plowing gives a greater quantity of material to plow under, but owing to its more mature condition it will break down too slowly, causing drying out and also reducing the nitrate content of the soil, thus adversely affecting vine growth.

The green manure crop should be sown as soon as cultivation ceases in mid-July. When sowing, a space of eighteen to twenty-four inches should be left on either side of the row to give a clear space for the pickers to walk in. This will remove some of the objection to oats and millet with their heavy fall growth. These crops may also be flattened down previous to fruit-picking, with a roller or stone boat.

FERTILIZERS

In common with other fruits, grapes require a soil adequately supplied with organic matter. In one of the Station fertilizer experiments the organic matter and green manure plots were the only ones returning an increase in crop yield sufficient to pay for the materials applied. This indicates the importance, especially where manure is not readily obtainable, of encouraging the growth of green manure crops by proper fertilization. The mineral fertilizers used to promote the growth of green manure crops will eventually be returned to the soil in the highly desirable organic form which is believed to be more suited to horticultural crop requirements than the inorganic form.

Barnyard manure and green manure crops should form the basis of the soil fertility program. These, with proper soil drainage and frequent, thorough cultivation during the first half of the season, will furnish all the plant food necessary in many vineyards, probably most of the vineyards of the Niagara Peninsula.



(Fig. 14) Size of bunch is largely dependent upon the vigour of the vine. (Top row) Bunches of grapes from vines possessing poor vigour. (Bottom row)—from vines possessing good vigour. Both taken from the same grapery.

Eight years' results from a carefully planned fertilizer experiment in the Haines vineyard at Jordan have shown very little benefit from surface applications of superphosphate and potash, the probable explanation being that the plant roots did not have access to the minerals applied in this way. Further experiments with deeper placement of the fertilizers are now under way. From our results it would seem advisable that minerals be applied deeply, and of necessity this should be done in the fall of the year so that the plant will have time to overcome the shock of root cutting before the start of next season's growth.

Taking a long view of the whole fertility problem, fertilizing the green manuring crop appears to be the best method of fertilizing grapes as, in the increased crop residue incorporated in the soil, the plant will have increased plant nutrients to feed upon. Also applying manure, straw, hay or other crop residue to the vineyard will give the plant an increased reserve for future growth and fruitfulness. The following recommendations keep this in mind (No. 4).

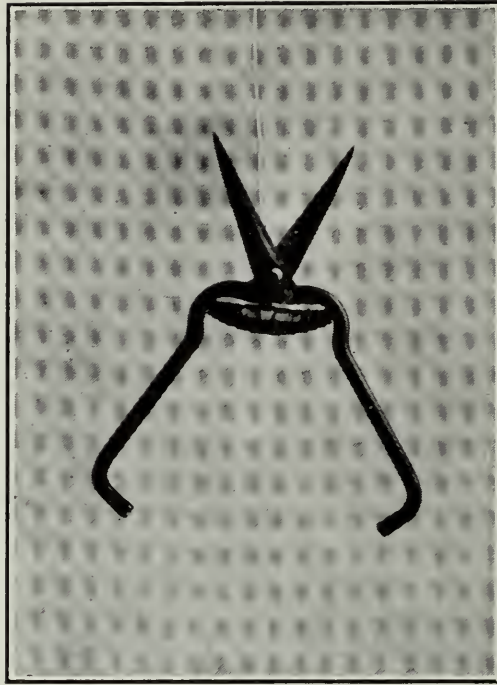
1. Barnyard manure at the rate of 10 tons per acre, applied at least every other year in order mainly to promote the growth of green manure crops. A supplemental application of 400 lbs. 0-12-15 per acre to balance the mineral requirements is suggested.

2. Where barnyard manure is not available and straw is obtainable, an application at least every other year of 2 tons of straw per acre with 200 lbs. of nitrate of soda (or equivalent) per ton of straw may be made. This nitrogen application is to be divided in fall and spring applications. In this case the nitrogen is used up entirely by bacterial action in the rotting of the straw. Supplement with 0-12-15 as in (1).

3. Where manure or straw are not available and where there is a surplus of legume hay, apply 2 tons of hay per acre without the nitrogen application. In this case there is enough nitrogen in the legume hay to satisfy the bacterial decomposition. Supplement with 0-12-15 as in (1).

4. Where a complete fertilizer is desired, an application of 600-800 lbs. of 4-8-10 per acre may be made every other year. This application will give some increase in vine growth and fruitfulness, but its main value is likely to be in promoting the growth of green manure crops.

5. Cease cultivation not later than the 15th of July, preferably before, and plant some suitable green manure crop such as millet, oats, etc.



(Fig. 15) *The best type of clipper to use in cutting the crop.*

HARVESTING

The one point in connection with harvesting which really needs stressing is that of proper maturity. A point often overlooked by some grape-growers is that some varieties colour many days ahead of maturity. It is believed, and no doubt with cause, that the placing of immature, extremely low quality grapes on the early market seriously interferes with the later marketing of better quality varieties.

Practically all varieties of grapes reach full size and have good colour several days before they are really fully mature. They are not mature, however, in the sense of full development of sugar content, which determines quality. The result is that many varieties are harvested before they should be. This is true of the green varieties such as Niagara, as well as red and blue varieties.

Along with the above fact of general colouring in advance of full and proper sugar development, it should also be noted and emphasized that **there is no appreciable increase in sugar content once the fruit has been cut.** Most kinds of fruit continue to "ripen" after picking, but not the grape. Ripening processes cease immediately the grape is cut. It is obvious, therefore, that grapes should not be cut, even if well coloured, until sugar development is sufficient to ensure good quality. Taste is an easily-made and sufficient test for all practical purposes.

Previous mention has been made of the premature harvesting of the crop, particularly of the early varieties, which colour well ahead of maturity. It has also been suggested that the marketing of this immature fruit has a depressing effect upon the subsequent sale of the later crop. Another point which might be of interest to the grower is the loss in crop-weight, which he might very easily have avoided by delaying harvest until the fruit was mature.

A four-year experiment, carried out at this Station from 1931-1934 with the varieties Niagara and Concord, clearly shows the loss in fruit weight caused by cutting before the crop was mature. By cutting two weeks ahead of proper maturity 11.4 per cent less crop was harvested of Niagara, and 9.6 per cent less crop for Concord. In other words, had the grower waited until the fruit was mature, for every ton of grapes he cut two weeks earlier he might have cut 2,228 lbs. of Niagara and 2,192 lbs. of Concord. Translated into six-quart baskets, this increase would amount to 25 baskets of Niagara and 21 baskets of Concord.

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BULLETIN 392

MARCH, 1938

Ontario Department of Agriculture

Statistics and Publication Branch

TORONTO, ONTARIO

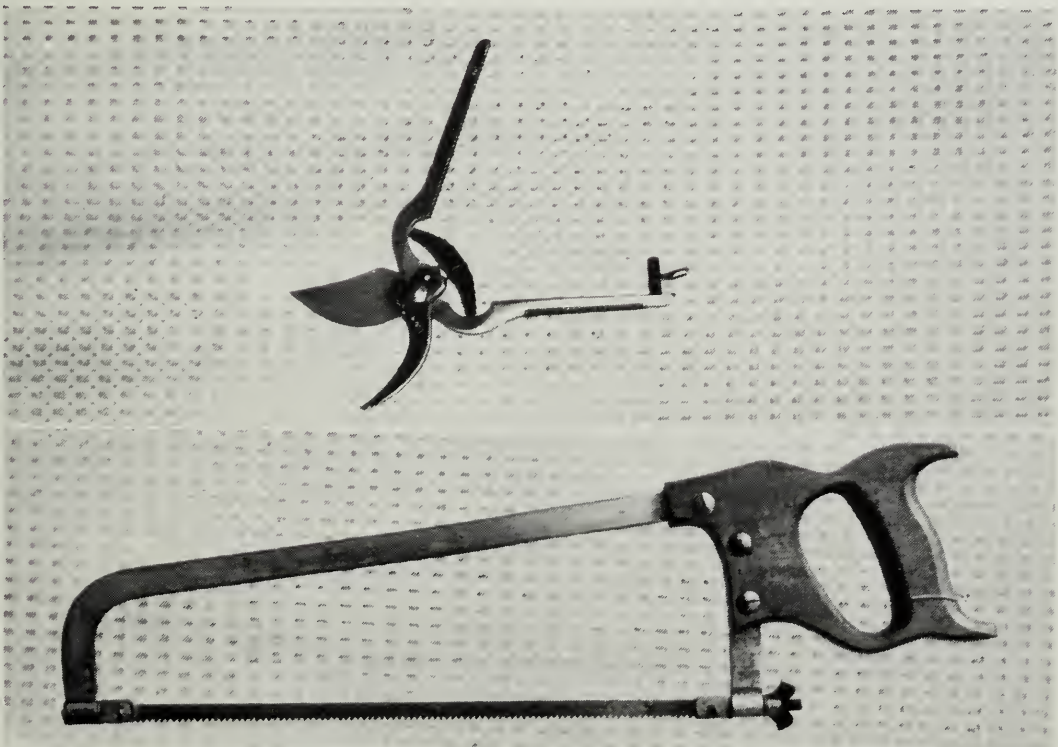
PRUNING THE TREE FRUITS

BY

W. H. Upshall

HORTICULTURAL EXPERIMENT STATION

VINELAND STATION, ONTARIO



Good types of pruning tools. The angle of the saw blade can be altered at either end, which is of advantage in making difficult cuts.

PRUNING THE TREE FRUITS

W. H. UPSHALL

HORTICULTURAL EXPERIMENT STATION

Vineland Station, Ontario

ALTHOUGH pruning has been a common horticultural practice for centuries, it is only during the past twenty years that experimental work has brought to light certain resulting effects. As every kind and variety of fruit has a growth habit distinctly its own, differences in pruning treatments are demanded, more particularly in the training of the young trees to a desirable form. It is now being realized therefore, that pruning is a very specialized task and that the men who do the work should have some knowledge of the basic principles and of the growth habits of the varieties with which they are dealing. Our hope is that this publication, which discusses pruning principles applicable to the apple, cherry, peach, pear and plum, will fill such a need. The thought throughout has been to emphasize these principles by picture rather than by the written word.

PRINCIPLES

(1) **Pruning dwarfs the tree.** Numerous experiments have shown that pruning is a dwarfing process, i.e., it reduces the total size of the tree. There is a certain deception in the effects of pruning in that strong growths with large leaves arise just back of large pruning cuts. This gives the impression that increased growth has been the result, but experimental work has shown that pruning, in proportion to its severity, reduces the total leaf area of the tree. This result can more readily be understood if we consider the leaves in their true role as the food manufacturing plant of the tree. Cutting away a live branch which, if left, would have borne leaves, is bound to reduce the output of the "factory", and the final result is a reduced bearing area.

(2) **Pruning at planting time dwarfs very little.** Investigations at this Station have shown that pruning at planting time has an insignificant effect in reducing the size of the tree. The reason may be that, because of root damage in nursery digging, a top pruning is not much additional shock or setback to the tree and, in some cases, may actually result in preventing the death of the tree. It is obvious therefore, that it is wise to **do at planting time as much as possible of the pruning necessary to build a desirable framework for the tree.**

(3) **Pruning the young tree delays fruit bearing.** Because pruning tends to force the growth of long, succulent shoots which grow late in the season, manufactured food is not allowed to accumulate in sufficient quantities

to result in the formation of fruit buds. Consequently the tree is kept in a juvenile or non-fruiting condition for a longer period of years. Young trees often grow very upright and become so dense that there is an inclination to thin out the branches. It has been shown on the other hand, that early fruit bearing will do a great deal more to open up the tree and do it more effectively than can be done by means of pruning. With the young tree this sequence should be kept in mind: light pruning, early bearing, a spreading tree. (Figure 1).*



(Fig. 1) *Effect of early fruiting on shape of tree. Adjacent eight-year-old Melba trees which were the same size when planted. They have been given the same cultural and pruning treatments, the latter very light. The tree on the left has been prevented from fruiting by removing the blossoms each year, while the one on the right has had a total yield of 99 lbs. The latter is about 40% smaller, but is a much more open tree as a result of fruiting in the early years. The background screen is 15' in height.*

After reading the above discussion on principles of pruning there may be some readers who raise the query: "Why do any pruning?" The answer is that pruning is a natural process. It takes place when limbs die and death is often caused by the excessive shading which is characteristic of a non-pruned

*Thanks are due Mr. J. R. van Haarlem, of the Station staff, for the photographic work necessary for this bulletin.

tree. Since the tree prunes itself in this way, our pruning job would seem to be the removal of all weak branches when they begin to become useless to the tree. Results obtained in Michigan show that most of the low grade fruit is produced on these weak-growing branches.

PRUNING TOOLS

Any factor which makes the work more pleasant encourages greater care on the part of the workman. For this reason suitable pruning tools (Front cover), kept in good working order, represent an investment which will give good returns. With such tools, clean, close cuts, which heal quickly, can be made.

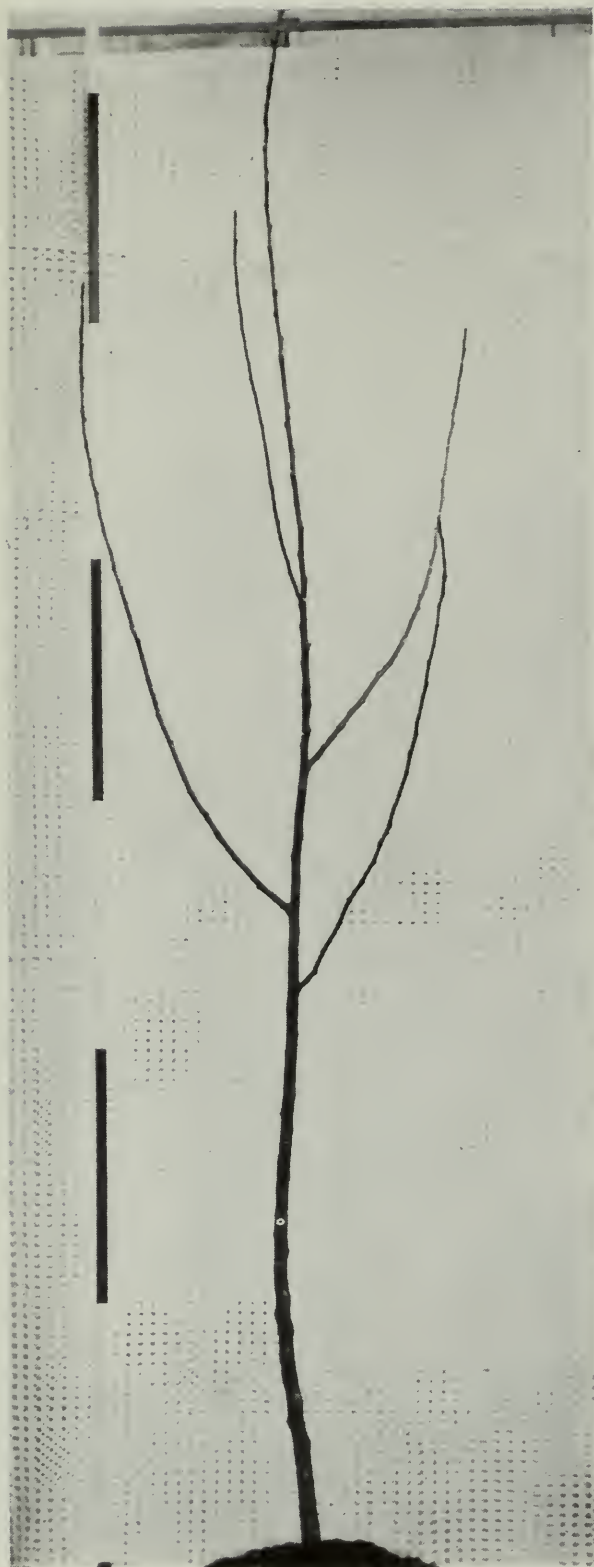
Pruning wounds should be made flush with the limbs where the unwanted branches are attached, and as close as possible to a bud when cutting back the previous year's wood. A stub at these points very much delays the healing of the wound, and quick healing is desirable in reducing infection from various organisms which cause cankers and wood decay. Even a bruising of the tissues when making a cut delays healing of the wound. As a saw makes a closer, cleaner cut than even the best pruning shears, it should be used wherever possible. Long-handled pruners make possible a speedy pruning job but, because they tend to encourage the leaving of stubs and the removal of larger branches, they cannot be recommended except in orchards where the trees are approaching the end of their profitable life.



(Fig. 2) Typical open centre type of tree (Spy). The sucker growth in the basal area indicates excessive pruning. Heavy pruning has been considered necessary to keep the centre open and to relieve the congestion of main branches and lower laterals. This heavy pruning, with its consequent crop reduction, could have been avoided by proper training in the first year in the orchard.

TYPES OF HEADS IN FRUIT TREES

Fruit trees can be trained by pruning to develop various forms. In European countries they are trained to take many different forms, some of which are designed for decorative purposes. In this country most of our orchard trees have been pruned to the **open centre type** of tree in which five or six main branches have arisen from nearly the same point on the main trunk (Figure 2), and in which the top of the tree has been kept open by pruning. This system has two main defects: (1) crowding of the main branches and narrow angles resulting in weak crotches and much breaking down, and (2), heavy pruning is required to keep the top open, particularly in the early years. The **central leader type** of tree is now recommended in preference to the open centre type for all trees except peaches and Japanese plums, which do not naturally retain a leader. The central leader tree consists of three to five main branches distributed vertically and spirally around the trunk (Figure 3), and with the topmost branch (leader) well in the lead of the lower ones. A vertical spacing of six to eight inches is desirable. If the branch angles at the main trunk are sufficiently wide (over 35°), there will be no bark inclusions in the crotches (Figure 4), and a strong tree will result.



(Fig. 3) Central leader type of tree. There are four main branches distributed vertically and spirally on the trunk and a leader which is well in the lead. If the branch angles are sufficiently wide, a very strong tree is the result. Measuring stick is marked in feet.

METHODS OF TRAINING

The pruning at planting time and for the next two or three years should be considered almost entirely as a training process. The ultimate strength of the head depends altogether upon the wise selection of branches and the maintenance of proper balance between these branches. Mistakes made in this formative period may mean weak trees and in addition, the correction of errors may call for severe pruning in later years—a pruning that would cut away considerable portions of the bearing area and at the same time create large wounds subject to infection. The importance of proper attention to building a strong framework in the early years cannot be over-emphasized.



(Fig. 4) Narrow crotch angle on a peach tree before and after removal of a slice of wood from the crotch area. The branch at the left which makes the sharp angle with the trunk should not have been saved as a permanent branch. In this instance the crotch has been further weakened by Canker.



(Fig. 5) Training one-year-old fruit trees by disbudding methods. Clothes pegs mark the selected buds and the direction in which the branch will grow. All other buds should be removed with a knife blade. The method on the right is recommended for all upright growing varieties, three buds being permitted to grow at each point. After the first year in the orchard the unwanted branches are removed.

1. One-year whips of apple, pear, plum and cherry.

As some one-year whips are being planted, it will be necessary to deal with training methods for them. As a general rule, whips should not be planted unless they are stocky and at least four feet in height from the bud union to the tip. Trees smaller than this present greater training difficulties.

All of the laterals which grew on these one-year trees in the nursery should be entirely removed. The whip should be headed back only if it is longer than 54 inches. By disbudding methods, i.e., the removal of all buds which are not needed to form permanent branches, it is possible to establish the permanent framework of the tree **in one season**. Disbudding can be done most easily and thoroughly when the buds are just ready to burst. At that time they can be flipped off very readily by means of a knife blade. Care should be taken to remove the "heart" of the bud else secondary buds may arise later and develop into branches. The lowest selected bud should be from 22 to 32 inches above the ground, depending on the habit of growth of the tree, upright growing varieties being headed low, and spreading varieties high. On all but the very upright growing varieties, five buds should be selected, the topmost one to form the leader and the lower ones to form the main branches. All should be spaced six to eight inches apart and arranged spirally around the trunk (Figure 5). Because of the danger of breaking off the selected buds or shoots, horses and implements should be kept well away from these trees until the shoots are three to four inches long. By this time they will be hardening at the base and much less easily knocked off.

Because of the danger of weak crotches as a result of sharp branch angles, it is recommended that in upright growing varieties, three buds be left at each point where a permanent branch is desired (Figure 5), selecting one year later the most suitable branch at each point and removing the others. Spy, Delicious, Wealthy and Melba apples, Bartlett and Kieffer pears and Black Tartarian cherry are well known examples of upright growing varieties which should be treated as above.

Some varieties develop very good heads without disbudding. McIntosh apple and all pear varieties are examples. On these varieties many buds along the length of the main stem burst and develop into branches, all of which have wide angles (Figure 6). After one year in the orchard, four suitably placed branches and a leader can be selected and all other branches removed. Except with the McIntosh apple and pear varieties, some disbudding system is demanded because of the failure of nearly all of the lower buds to grow out into branches from which a selection can be made for a proper central leader tree (Figure 6).



(Fig. 6) Illustrating differences in kinds of fruit trees in their branching habit from one-year whips. McIntosh apple and all common pear varieties branch like the tree at the left (pegs mark selected branches), while most other tree fruit varieties branch like the tree at the right. On the latter, all side branches can be cut off and by disbudding, a new head can be established.

2. One-year peach.

Practically all nursery peach trees are sold at one year of age. They are usually very well branched on a long, main stem, and for that reason present a slightly different training problem to the other tree fruits of the same age. Trees four feet and up in height are desired with three and a half feet as a minimum.



(Fig. 7) A well-branched nursery peach tree before and after pruning. There is no need for heading back the selected branches.

With peaches, spacing of branches six to eight inches apart is of the utmost importance, and when trees are shorter than the above minimum they must have a reduced number of branches or closer spacing, both of which are undesirable. When trees have a good branching system, four to five branches may be selected and all others cut away as close as possible to the trunk (Figure 7). The lowest branch should be about 20 inches above the ground level. In nursery handling and delivering many peach branches are broken at the point where they join the trunk; this injury is almost certain to cause the death of the branch and care should be taken that only undamaged branches be left at the time of the first pruning. These branches should not be headed back, but if any laterals occur on the stronger ones they may be removed, which will reduce their growth and tend to balance the tree. As



(Fig. 8) A poorly-branched nursery peach tree before and after pruning. This tree must be reduced almost to a whip, removing weak branches entirely, and cutting stronger ones to the bud nearest the base. On many trees there will be buds at the junction of the branch and main trunk. After the shoots grow to an average length of $1\frac{1}{2}$ inches, the unwanted ones may be removed, or the selection of permanent branches left until the following spring.



(Fig. 9) Normal two-year-old nursery tree before and after pruning. If a strong central leader type of tree is to be developed, only one or two permanent branches and a leader can be retained at planting time. By cutting these selected branches to one or two-bud stubs, the tree may be disbudded as recommended for one-year apple, pear, plum and cherry trees.

peach trees do not maintain a central leader naturally, it is quite good practice to prune off the central leader at 44 to 48 inches above the ground immediately after planting.

When peach trees are poorly branched or when many of the branches have been injured, it will be necessary to prune the tree almost to a whip, but leaving the main trunk as long as possible up to 44 to 48 inches (Figure 8). If there are insufficient buds situated directly on the main trunk, there will be need of leaving buds at the bases of all strong branches, preferably at the junction between branch and main trunk. If the cuts are made too close at these points the buds will be destroyed. Where no buds are present at the junction point it will be necessary to leave a stub at the end of which there is a bud. The cut should be made as close as possible to this bud. When the young shoots are about $1\frac{1}{2}$ inches long on the average, four or five suitable ones should be selected to form the permanent branches and all others should be removed completely. The reason for delaying the training in the case of the peach is that the starting of buds in the spring is much less certain than with the other fruits.

3. Two-year and older apple, pear, plum and cherry nursery trees.

The average two-year and older nursery tree presents a rather difficult problem in training to the central leader system. It is much better adapted to the less desirable open centre type of tree, and this is one reason that so many of our orchard trees come to be of this form. The common nursery practice calls for the heading back of one-year whips to a height of about 30 inches. This results in a crowding of branches, many of which are sharp-angled, immediately below the cut (Figure 9). If we assume that, on the average, the lowest branch must be 27 inches from the ground, it can easily be seen that only one of the nursery branches can be saved, and that the others, being too close, must be removed. It will then be necessary to obtain two or three main branches arising from the leader the first or second year in the orchard. As the first branch selected will be one or two years ahead of the other branches, it must be pruned rather severely to keep it down in size. The writer is inclined to believe, though lacking experimental proof at the present time, that it would be wiser in the long run to prune the selected branch to a one or two-bud stub. This reduces the two-year and older tree almost to the state of a very large whip, and in this condition it can be treated as outlined for one-year trees (Figure 9).



(Fig. 10) Keeping a tree balanced. Three-year-old peach tree before and after pruning. The branch at the left, considerably larger than the others and almost as large as the main trunk, can be dwarfed by the removal of the lower laterals. This is all the pruning necessary for this tree at this particular time. Note the well spaced branches and wide crotch angles resulting in a strong tree.



(Fig. 11) Disadvantages in heading back to a bud. These trees were two years old when planted, and have been in the orchard two years. The branches of one (left) were cut back to one-half their length at planting time, and in the other one (right) the branches were left full length. Note the greater crowding of lateral branches and sharper angles on the tree at the left. Clothes pegs mark the end of one branch on each tree after the planting time pruning.



(Fig. 12) Fourteen-year-old apple tree before and after pruning. Only a few lower branches, which were becoming weak and a nuisance in cultural operations, were removed. There was no weak wood in the top of this tree, and, therefore, little or no need for pruning in this area. The tree looks dense even after pruning, but will be much more open when the fruit crop weights the branches down in the summer and fall.



(Fig. 13) Six-year-old peach tree before and after pruning. Most of the pruning has been done in the lower portion of the tree. The wood removed was the type which bears inferior late ripening fruit, and is therefore not a great loss. This tree is not yet too high, and it would be a mistake to remove wood from the top of tree where the best peaches are produced. Fruit thinning will be more necessary with lightly pruned trees than with heavily pruned trees. Older peach trees should be pruned more heavily than this one.

4. Pruning young non-bearing trees after the first summer in the orchard.

With all of the permanent branches selected within one year after planting, pruning for the next two or three years should be designed to keep the leader slightly in the lead and to have the branches develop uniformly. Where one branch is becoming larger than the others, some laterals should be taken from it to reduce its growth (Figure 10). **The removal of laterals, which, fortunately, are more abundant on the stronger growing limbs, is a much better way to dwarf the branch than is heading back.** Heading back to a bud always results in a crowding of branches back of the cut, and often the branch angles are very sharp, resulting in weak crotches (Figure 11). Concerning laterals from the main limbs, it is recognized that those occurring within 18 inches of the main trunk are not likely to be permanent, and should be removed as early as possible. The above recommendations apply to peach and Japanese plum trees except that there is no true central leader.

PRUNING BEARING TREES

Referring again to work done in Michigan, it has been shown that the pruning of bearing trees can be made a very unprofitable practice. Where there was removal of large, vigorous branches, particularly from the tops of the trees, the improvement in grade of fruit was quite insufficient to make up for the loss of fruit from the branches which had been removed. In the case of apple trees they recommend the removal of weak growing branches only as it is on these that a large part of the inferior fruit is borne. Most of this weak growing wood is to be found in the lower and interior portions of the tree (Figures 12 and 13).

Proper training in the early years should eliminate much of the heavy pruning required in later years in many orchards, and under normal conditions the only pruning necessary is the removal of weak and dead limbs. Heavy pruning will keep trees in a good state of vigour, but the same result can be obtained in a more far-sighted way by attention to the fertility of the soil and by adequate planting distances. Cases where heavy pruning may be justified are as follows: (1) where permanent trees have been planted too closely; (2) filler trees which are crowding the permanent trees; (3) trees with restricted root systems on shallow soils or soils with high water tables; (4) neglected trees which have become very dense.

A regular annual pruning is to be preferred to a heavy pruning every three or four years. A heavy pruning upsets the balance of the tree as is indicated by an abnormal growth of suckers (Figure 2). It may throw the

tree partially out of the fruiting condition. In cutting out suckers, the cuts should be made flush with the parent limb else a second crop of suckers may arise next year from the same point (Figure 14).



(Fig. 14) Proper and improper methods of making cuts. On the branch at lower left, two flush cuts and one careless cut are shown. In the latter case, a one-inch stub was left. This may lead to a crop of suckers at this point or in the absence of buds, a dead stub, both results being undesirable.

Many fruitgrowers begin to worry too soon about their trees getting too high, and they commence quite early to reduce the height. This practice often results in a very strong growth in the top of the tree, which causes excessive shading of the lower areas, weakening the growth there and eventually resulting in dead branches. This means that the main bearing area actually becomes higher rather than being kept low. Trees should not be headed back until they are too high for profitable management. It is an easy matter then to reduce the height by cutting to a sturdy outward growing limb. This height reduction process should be spread over two or three years so that the balance between growth and fruiting may not be upset. Many of the varieties of

spreading form may never need such heading back, as the weight of the fruit crops will keep them from getting too high (Figure 1).

Because of the danger of a severe winter freeze it is advisable to delay pruning as long as possible. Then, also, the shorter the time the pruning wounds remain exposed before healing commences the less the danger from infection. It is generally considered inadvisable to prune trees while the wood is frozen. After a severe freeze, during which the tissues of the top of the tree



(Fig. 15) Renewal of a peach branch which is becoming weak as a result of canker infection. The branch at the right has a large canker. About a foot below this canker a strong sucker arose, and having been retained, it can be used to replace the old limb which very shortly will be dead or broken down.

have been damaged, as shown by their discoloured state on thawing out, trees should be left unpruned for a year or two. This treatment, allowing for the greatest possible leaf surface, insures a quicker recovery from the injury.

Because of the prevalence of the Peach Canker disease in Ontario, it is of special importance that peach trees should not be pruned before late winter or spring. The older trees should be pruned first, finishing up with the newly planted ones. As a supplementary measure, it is recommended that all peach trees, especially newly planted ones, be given a second pruning in June for the removal of dead wood. In this operation cuts should be made several inches back of the dead wood, i.e., in healthy tissue where wound healing will proceed rapidly.

When, through winter injury or canker, a main limb shows signs of becoming weak, it is often possible to retain near the tree trunk an upward growing sucker, which may later be used to replace the original limb (Figure 15). Where the whole tree has been badly weakened as a result of winter injury, and growth is very weak, its condition calls for removal of the tree rather than renewal pruning.

Most pear varieties and a few apple varieties are very subject to the Fireblight disease. With these, over-stimulation of growth as a result of heavy pruning or heavy feeding may be disastrous as succulent growths are very susceptible to attack. Young trees should be given very light pruning to encourage early fruit bearing, which in turn will check growth (Figure 1). In these varieties, suckers growing from the trunk or main branches should be removed early in their first season, because the Fireblight disease may work down through them and into the main framework where it may seriously weaken or even kill the tree.

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BULLETIN 393

MARCH, 1938

Ontario Department of Agriculture

Statistics and Publication Branch

TORONTO, ONTARIO

Insects Attacking Vegetables

-- BY --

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Insects Attacking Vegetables

BY

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INTRODUCTION

Any person who has to combat insect pests can do so more intelligently if he keeps in mind the following things:—

1. Most insects, as all beetles, moths, and two-winged flies, pass through four stages—egg, larva, pupa, and adult. For instance, in the case of the house fly there are the little white eggs, laid usually in fresh horse manure. These hatch into tiny, white maggots which feed on the juices of the manure until full-grown, at which time they are about half an inch in length. Then these change into pupae, which are like large, plump grains of wheat but are brown or reddish-brown in colour. These in turn change into adults (winged flies) thus completing the life cycle.

During the pupal stage insects do not feed but remain inactive while the internal changes, which transform them into adults, are taking place.

2. Other insects, as grasshoppers, plant or leaf bugs, leaf hoppers, scales, and aphids, instead of passing through the above four stages in their life cycle pass through only three—egg, nymph or larva, and adult. Hence in these insects there is no pupal stage. In their case the larvae are usually called nymphs. Most nymphs resemble closely the adult except that they have no wings.

Aphids during the summer are an exception to the above rule in that they lay no eggs but give birth to living young. In late autumn, however, they do lay eggs and this is the stage in which they winter in the open.

3. For our purpose all insects may be divided into two great classes:—

(a) those having biting mouth-parts.

(b) those having piercing and sucking mouth-parts.

These two classes may be distinguished from each other easily by observing how they feed or the effect of their feeding. The biting insect always eats pieces out of the plant, leaving holes or jagged margins. The piercing and sucking insect never does this but merely punctures the surface of the plant with its fine, sharp, needle-like beak and then sucks the juices up from the interior. The injury to the plant in this case comes from the loss of its juice or sap and sometimes also from a poison injected into the tissues by the insect when feeding.

4. Biting insects may in most cases be combated by spraying or dusting the plants on which they feed with a poison, such as arsenate of lead, arsenate of lime, or paris green. These poisons are often called stomach poisons, because the insect in feeding takes them into its stomach and is thereby poisoned.

Piercing and sucking insects cannot be killed by stomach poisons, because they feed only on the juices drawn from beneath the surface of the plant, and so cannot get the poisons into their bodies. They may be combated by contact poisons; that is, by hitting them with a spray or dust that kills them by contact or by fumes given off. Such poisons are nicotine sulphate 40 per cent., oil emulsions, soap sprays, nicotine dust, pyrethrum sprays and dusts. Remember that to kill a sucking insect the poison must hit it.

6. All larvae and nymphs are more easily killed when young and small than when full-grown or nearly so; hence it is usually wise to spray injurious insects as soon as possible after the eggs have hatched.

7. Thoroughness of application is very important; for, if a plant is only half covered with the spray, sufficient insects will often escape destruction to continue breeding and cause much loss.

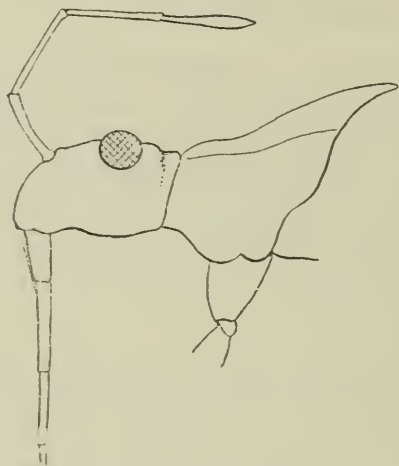


Fig. 1.—Head of piercing and sucking insect, showing long, slender beak and fine, needle-like lance, which pierces through the surface of the leaf or plant. (R. Ozburn.)

8. Since many pests winter over as eggs, larvae, pupae or adults on plants left in the field or under rubbish or in weedy or grassy places, it is often a great help to make a practice in the fall of cleaning off all the rubbish and ploughing under or burning all the crop remnants, and in the spring burning over early all weedy and grassy places before the insects become active.

STOMACH POISONS OR POISONS FOR BITING INSECTS

The chief stomach poisons used against biting insects are: arsenate of lead, arsenate of lime (calcium arsenate), paris green, barium fluosilicate, cryolite, and derris.

Arsenate of Lead. This is a white substance usually sold in powder form and only rarely as a paste. It may be used either in water alone or in Bordeaux mixture, and may, if desired, be combined with nicotine sulphate. The addition of soap to it or to either of the following poisons tends to cause burning if the spray is allowed to stand for some time instead of being applied at once. The usual strength for most plants is $1\frac{1}{2}$ lbs. to 40 gals. of water, or 3 level tablespoonsful to 2 gals. If used as a dust it may be diluted 1 part to 4 to 10 parts of hydrated lime, gypsum, or talc. Arsenate of lead sticks on the foliage longer than any other stomach poison.

Arsenate of Lime, known also as **Calcium Arsenate**. This poison looks

just like arsenate of lead and like it is nearly always sold as a powder. It contains about a third more arsenic than arsenate of lead and costs only a little more than half as much per pound. It is a good sticker, but not so good as arsenate of lead. On most plants it is a little more inclined to burn the foliage than arsenate of lead, but is safe on many plants and especially so on potatoes, for which it is the cheapest and most desirable stomach poison. The strength at which it is commonly used is 1 lb. to 40 gals. of water or of Bordeaux mixture. In small quantities this would be 1½ level tablespoonfuls to 1 gal. On potatoes this strength should be doubled. As a dust it may be diluted at the rate of 1 part to 6 to 15 parts of hydrated lime, talc or gypsum. It is less likely to burn as a dust than as a spray. If used as a spray with Bordeaux mixture there is practically no danger of burning.

Paris Green. This is a green powder. It kills quickly and would be an excellent poison were it not that it washes off easily and tends to burn most kinds of foliage. It is much more costly than arsenate of lime. For these reasons it is rapidly being superseded by arsenate of lead and arsenate of lime. The strength at which it is commonly used is ½ lb. to 40 gals. of water or of Bordeaux mixture. For potatoes this should be doubled. In small quantities use about 1 dessertspoonful to 1 gallon of the liquid. As a dust paris green may be diluted with 10 to 20 times its own weight of hydrated lime, gypsum, or talc.

Barium Fluosilicate and Cryolite. These are fluorine compounds and are valuable against a few pests such as blister beetles and flea beetles. They are not, however, nearly so much used as arsenicals and at the present time are not readily obtainable in this province. Like most other insecticides they may be used either as sprays or dusts. The strength for the former is 1 lb. to 40 gals. of water; for the latter 1 part to 1 to 5 parts of talc, gypsum, flour, or fine road dust. They should not be mixed with hydrated lime or quick lime as this destroys their killing power. Moreover they are not compatible with Bordeaux mixture, lime sulphur, nicotine, or several other spray materials. Like arsenicals they should not be used on any foliage or fruit that will soon be marketed or consumed, because they are poisonous.

Derris. This is a light brown powder made from the roots of certain tropical shrubs. The killing principle or material in this is known as rotenone. Derris is both a stomach and a contact poison and is very effective against a number of insects. It has not yet, however, been much used in this province against vegetable insects but probably will be used to a considerable extent in the near future, as it does not burn foliage and is not very poisonous to man or livestock. It is, however, more costly than arsenicals. It may be used either as a spray or a dust. When used as a spray the strength is 1 to 2 lbs. to 40 gals. of water. The addition of 2 qts. of skim milk or ½ lb. of skim milk powder or of soybean flour increases the killing power. If used as a dust it may be diluted with about 6 times its own weight of talc, fine clay, or flour. Hydrated lime or soap should not be used with derris as they destroy or lessen its killing power.

CONTACT POISONS

The chief contact poisons used against vegetable insects are—nicotine, pyrethrum, derris, soap, corrosive sublimate, calomel, and lubricating oil emulsions.

Nicotine. This is chiefly used in the form of nicotine sulphate 40 per cent., which is a concentrated liquid extract of tobacco containing 40 per cent.

of nicotine. It is commonly used at the strength of 1 pint to 100 gals. of water or 1 dessertspoonful to 1 gal. of water. The addition of 5 lbs. of soap or soap powder to every 100 gals. of the spray, or 1 heaping tablespoonful to 1 gal., increases the spreading and killing properties.

Nicotine sulphate may be mixed with hydrated lime and then can be used as a dust. The dust for most insects should contain about $2\frac{1}{2}$ per cent. of nicotine. Usually this dust is bought ready made from some of the spray companies, but can be prepared by the grower himself. For the method of preparation write to the Department of Entomology, Ontario Agricultural College, Guelph.

Nicotine is an excellent insecticide against aphids, leaf hoppers, and several other small insects. To be effective it must be applied on a calm, warm day and the insects must actually be hit by the spray or dust. A windy day blows the fumes away and prevents them from killing the insects; a cold day makes the insects too inactive to inhale much of the fumes.

As nicotine is volatile it will soon lose its strength unless it is kept in air-tight containers.

Pyrethrum. This is a fine brownish powder made from the ground-up flowers of certain kinds of pyrethrum plants. The killing principle or ingredient in it is known as Pyrethrin 1, and Pyrethrin 2. This active principle may be extracted from the powder by means of various substances such as kerosene, acetone, alcohol, or ether. Taking advantage of this fact manufacturers have been able to prepare valuable sprays and dusts containing definite amounts of the poison. Some of these commercial sprays are much used. However, pyrethrum itself may be used as a dust by combining it with equal parts of talc or clay or cheap flour; or it may be used as a spray at the strength of 2 lbs. to 40 gals. of water, or 1 ounce to 1 gal.

Like derris, pyrethrum should not be used with hydrated lime because this soon causes it to deteriorate. If used with soap it should be applied promptly after this has been added. The amount of soap recommended is 5 lbs. to 100 gals. of spray, or 1 ounce to 1 gal.

Pyrethrum is non-poisonous to man and very rarely burns any kind of foliage.

Caution. Both pyrethrum and derris deteriorate quickly if exposed to sunlight. They should, therefore, be kept in the dark in closed containers. It is wise always to get the pyrethrum as fresh as possible because old pyrethrum is likely to be very weak.

Derris. See above under Stomach Poisons.

Soap. As said above, soap is often used with nicotine to increase its spreading and killing properties. It is also used alone with water at the strength of 1 lb. to 5 to 10 gals., especially for the control of turnip and cabbage aphids. It should not be used on tender foliage as it is likely to burn. The most convenient form for use is powdered soap, because this can be added directly to the spray while the agitator is running and soon goes into solution. If soap bars or cakes are used they must first be sliced and dissolved in boiling water. Linseed oil soap or other soft soaps may be dissolved in cold water by stirring, but they can be dissolved much more quickly if the water is hot.

Corrosive Sublimate (bichloride of mercury). This is a heavy white

material. As an insecticide it should be purchased only in a finely powdered form. It is a deadly poison both to man and beast. Its chief insecticidal use is to control the maggots which attack the roots of cabbage, cauliflower and radishes. The strength required and the method of application are given later in the text under the heading "Cabbage Maggot."

Calomel (mercurous chloride). This poison may be procured as a very fine white powder and in this form has been found valuable as a control for the onion maggot. Full directions for its use are given later where this insect is discussed.

Oil Emulsions. These are seldom used for any other vegetable insect than the onion maggot; hence it seems desirable to postpone directions for making, diluting, and using them until we come to the section of the bulletin dealing with the onion maggot.

Bordeaux Mixture. This material is much used as a fungicide for vegetables, but in a few cases it serves as a good insecticide, chiefly by its strong repellent action. It is one of the best means of control for potato flea beetles and potato leaf hoppers. The following is the method of making the mixture:

Formula: Bluestone (copper sulphate)	4 lbs.
Hydrated lime (fresh)	6 lbs.
Water	40 gals.

This formula is commonly called the 4-6-40 formula. Nearly fill the tank with water; add the proper amount of dissolved bluestone; start the engine to agitate the liquid; add the lime slowly, and agitate the mixture for about 5 minutes. If a hand outfit is used agitate by pumping the liquid back upon itself for 5 minutes. The result is Bordeaux mixture.

Note:—The easiest way to dissolve bluestone in the crystal or lump form is to place 40 lbs. of it in a bag and suspend this in a barrel containing 40 gals. of water in such a way that the bottom of the bag sinks only 4 or 5 inches below the surface. Leave over night and in the morning all will be dissolved. One gallon of the liquid when stirred will now contain 1 lb. bluestone. Small quantities can be dissolved rapidly in boiling water by stirring. Powdered or snow bluestone dissolves readily if placed in the desired amount upon a burlap screen on the hopper or inlet of the tank and the water poured over it as the tank is being filled.

Caution. Bluestone will corrode iron or tin, hence wooden or copper vessels should be used for handling or storing it. Remember, too, that it is poisonous to livestock.

Bordeaux dust is sometimes used as an insecticide instead of Bordeaux spray, but is not so effective. It is made by thoroughly mixing together fine monohydrated bluestone and hydrated lime in the proportion of 12 to 15 lbs. of the former to 88 to 85 lbs. of the latter. An arsenical is sometimes added to the dust by simply substituting 8 or 10 lbs. of arsenate of lime for an equal number of pounds of the hydrated lime mentioned above.

Sulphur.—This is used chiefly as a fungicide, but more for the diseases of fruit trees than of vegetables. It is, however, either alone or when mixed with hydrated lime, one of the best means of control for the tarnished plant bug on celery.

DUSTERS AND SPRAYERS

It is very important that every vegetable grower have either a good sprayer or duster, or preferably both. Dusters are lighter to handle and for some insects are probably more satisfactory than sprayers, but dusts usually cost more than sprays. Moreover, dustings should be done only on calm days and preferably while there is dew on the plants. For small gardens a little cheap duster costing about \$2.00 will sometimes suffice, but it is slow and often tiresome to operate. A good hand duster of the rotary or bellows type costing around \$20.00 is much better and is satisfactory for an acre or two of plants. With this the dust can readily be applied to either surface as desired. For the larger acreages, power dusters, of which there are many kinds on the market, are rapid and make it possible to cover the plants very thoroughly. A long trailing sheet of strong factory cotton attached to a boom above the outlets may be used to concentrate the dust on the plants and will thereby secure a much higher kill. This kill can be still further increased by driving the machine very slowly.

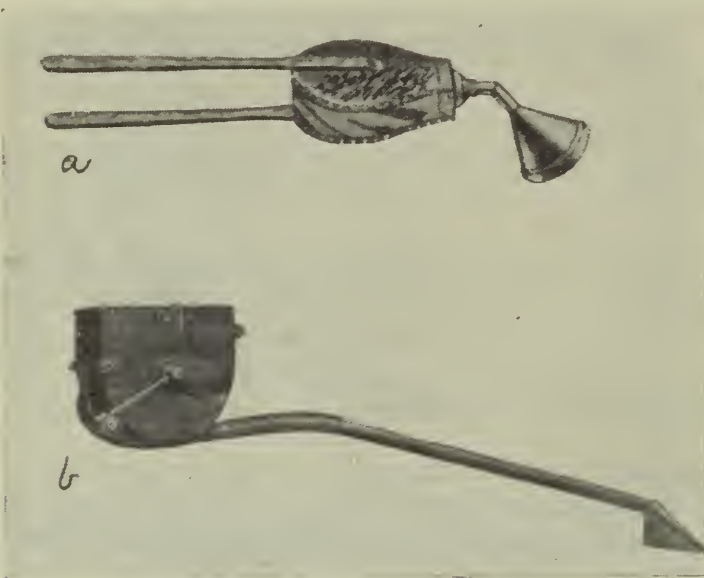


Fig. 2.—(a) Small, cheap, hand-bellows duster; (b) larger duster of rotary type, carried by straps over the shoulders.

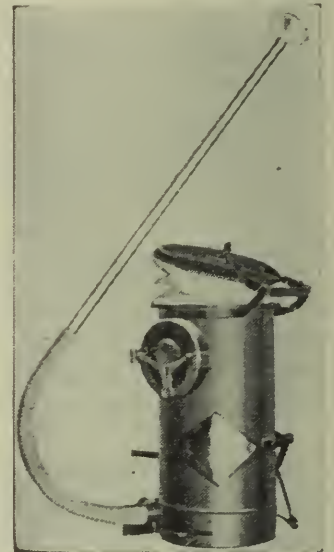
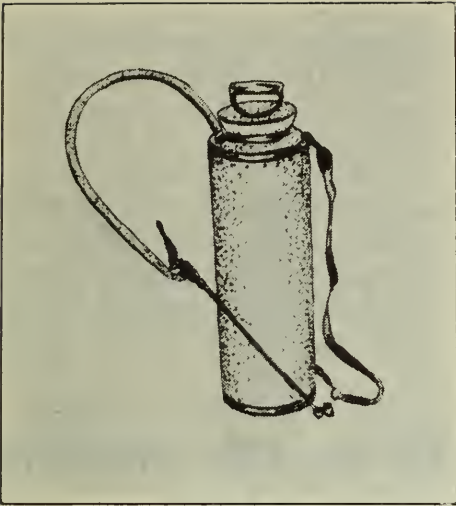


Fig. 3.—Large type of bellows duster, carried by straps over the shoulders.

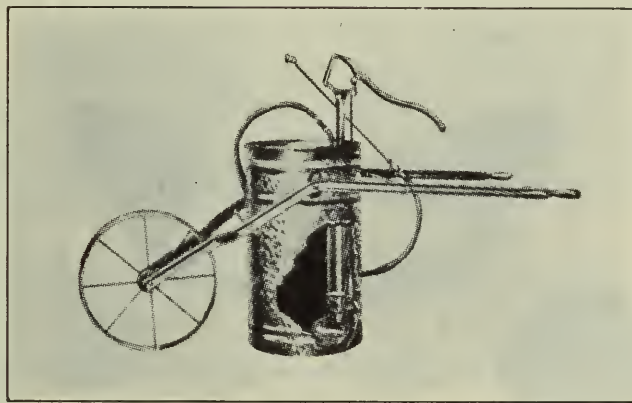
Sprayers, on the average, give better results than dusters, but as a rule are more cumbersome and slower. They can be used, however, in almost any kind of dry weather unless it is very windy. Small compressed air types holding 2 to 3 gals. may be purchased for about \$4.00 each and are fairly satisfactory for small gardens. Bronze knapsack 3-gal. sprayers, carried on the back, are much better and are satisfactory for about 2 acres or more of vegetables. They can also be used on small fruit trees. They cost from about \$15.00 to \$20.00, and if properly looked after will last a long time. Barrel outfits of 40 gals. capacity mounted on a cart and equipped with about 20 ft. of hose and a 3½ ft. rod curved upwards at the tip and capped with a large disc nozzle, are very satisfactory and enable the grower to spray the under surface as well as the upper when necessary. If only one man is to operate this type of sprayer he can do so by having a duplex outlet on the barrel to which two lines of short hose can be attached and the nozzles on these fixed at a stationary angle so that they will send the spray on the plants from both sides of the row. This type of sprayer, apart from the cart, will cost from \$25.00 to \$40.00. For areas of 5 acres and upwards a power outfit



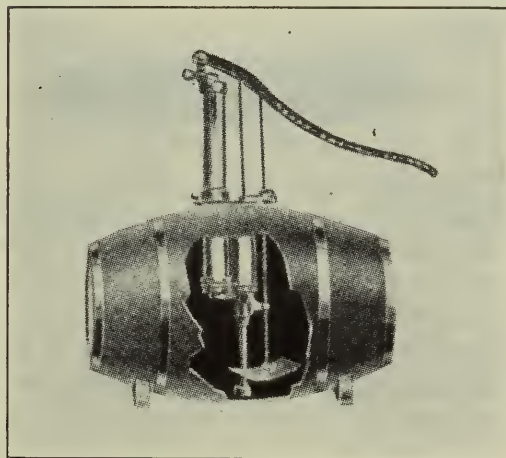
A 2-gallon compressed air sprayer.



A 3-gallon knapsack sprayer.



A 10-gallon wheelbarrow type of sprayer.



A 40-gallon barrel sprayer, showing pump and agitator.

equipped with 3 nozzles for each row and covering 3 or 4 rows at a time with a pressure of 200 to 400 lbs. per nozzle, will prove to be a great boon. Orchard sprayers may easily be adapted for spraying vegetables. The larger power dusters and sprayers cost from \$300.00 to \$750.00. Advertisements of sprayers and dusters may be seen in horticultural and agricultural magazines, and catalogues may be obtained from the spray companies.

No matter what kind of duster or sprayer is used it should receive careful attention and be well washed out with clean water after each application. Before putting it away for winter it should not only be thoroughly cleaned but also oiled to prevent rusting or corroding. Each spring it should be carefully overhauled and put into excellent working condition. With proper attention a good outfit will last for about ten years.

INSECTS WHICH ARE NOT LIMITED TO ANY ONE KIND OF PLANT BUT ATTACK MANY KINDS

CUTWORMS AND ARMY WORMS

Army worms are true cutworms and therefore may properly be considered here as such. The reason they have received the name "army worm" is that they have developed to a greater degree than other cutworms the habit of marching, often in great numbers, from one field crop to another when in need of food.

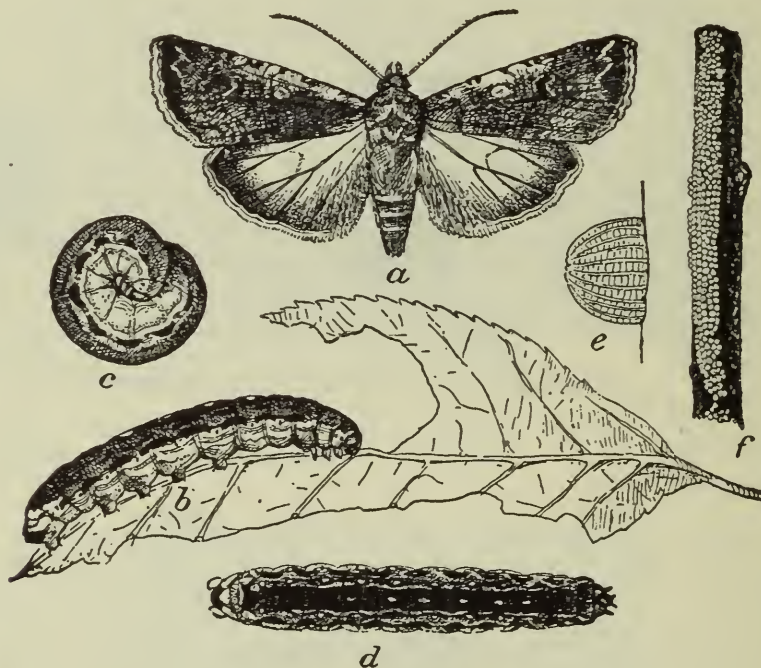


Fig. 8.—Variegated cutworm—(a) moth; (b,c,d) cutworms themselves in various postures; (e) egg greatly enlarged; (f) egg masses on a stem (after Howard, U.S.D.A.)

Cutworms are stout, hairless caterpillars about one and a quarter to almost two inches long when full-grown. Figure 8 shows their natural size and also their habit of curling up when at rest. The colour varies with the species, some being nearly white, others dark-greasy-gray, others brown and others black. Some are a uniform colour all over except that the under side is usually lighter than the upper; others have characteristic bands, stripes or lines along the back or side; and still others have black or other coloured markings on the back. All have three pairs of true legs and nearly always five pairs of false legs.

The adults are stout-bodied, dull-coloured moths with a wing expanse of one and one-quarter to one and one-half inches. The colour here, too, varies with the species but almost all are some shade of grey, brown or black, or a combination of these. The moths hide by day and fly at night.

There are many species of cutworms but usually not more than two or three of these are injurious the same year, and some, for instance, the army worm (*Cirphis unipuncta*), usually only once in ten or twenty years. Our most common and most destructive species are probably the red-backed (*Euxoa ochrogaster*), the variegated (*Lycophotia margaritosa*), the spotted (*Agrotis c-nigrum*), the glassy (*Sidemia devastator*), and the greasy (*Agrotis ypsilon*).

Injury.—Although most species have two broods a year, the first in May and June and the second in July and August, the greatest damage, as a rule, takes place in May and early June. The army worm is an exception to this as it does nearly all its damage in July. The variegated and the spotted cutworms are also sometimes quite destructive in July and August.

Cutworms work chiefly at night, hiding by day just under the surface of the soil or under the shelter of leaves or rubbish. Most of them, as the name indicates, cut the plants off at the ground or slightly beneath it. In this way even a comparatively small number can do great damage to cabbage, tobacco, tomatoes, corn or any other crop in which the plants are in hills or set far apart. The glassy cutworm and one or two other species, instead of cutting the plants at the ground, feed almost entirely beneath the surface and kill the plants by attacking the roots. Some species have the habit of climbing the stalks of plants, even of fruit trees, and of feeding upon the foliage. These are often called climbing cutworms.

There is scarcely any kind of cultivated crop which is not subject to cutworm attack. Many weeds and uncultivated plants are also attacked.

When the worms are abundant and nearly full-grown they sometimes destroy whole fields of wheat, oats, corn, tobacco, or other crops; in fact, there is scarcely any other insect in the Province except grasshoppers which can do so much damage in so short a time.

The injury is almost always more likely to take place when the crop has been planted on a field which was in grass, clover, or weeds the previous fall.

The adults feed upon the nectar of flowers and do no injury to plants.

Life History.—Nearly all our destructive species winter either as partly grown larvae or as eggs in the soil, and in both cases the larvae attack the plants in May and June. Those of most species become full-grown before the end of June and then pupate in the soil. By the end of the month or early in July the moths appear and lay their eggs usually on weeds or grass, though some, for example, the red-backed cutworm moth, lay them in the ground. The favourite place for egg-laying is where there is dense foliage such as long grass or weeds. The second brood of larvae becomes full-grown usually about the end of July or early in August. The moths from the pupae of these lay eggs during August and September. The larvae from these eggs become partly grown by winter and remain over winter in the soil. The eggs of the red-backed species, however, do not hatch until the next spring.

Control.—1. It has been stated that the moths prefer to lay in long grass or weedy places or where there is dense vegetation; hence if a crop is to be

put on such soil it should be ploughed as early as practicable in August and cultivated occasionally to keep down weeds the rest of the season, so that eggs will not be laid there, or, if they have been laid before the ploughing, they and any larvae that may have hatched will be destroyed by starvation.

2. When cutworms have begun to attack plants the best method of control is to use a poison bran bait. There are many formulae for such a bait. A cheap and apparently as good a one as any is :

Bran	25 lbs.
Paris green, or very fine white arsenic	1 lb.
Cheap molasses	½ gal.
Water, enough to moisten the bait, about	2½ gals.

In many cases, but probably not in all, the molasses may be omitted without lessening the value of the bait.

Mix the bran and one of the poisons thoroughly ; then after mixing the water and molasses gradually pour the liquid on the poisoned bran and mix until all is wet and will fall like sawdust through the fingers. The mixing may be done in any large vessel or on a cement or wood floor.

Half a teaspoonful or even less of the above mentioned bait dropped near each plant but not touching it will be sufficient.

If whole fields or large areas are attacked, scatter the bait at the rate of about 15 pounds (dry weight) per acre over the ground soon after sunset on a warm, dry evening, never on a cold or wet evening. This time of the day is best because the cutworms begin to feed then and like the bait fresh. Usually one application is sufficient, but sometimes a second is necessary.

3. If it is known or suspected that cutworms are in the soil prepare the ground in spring for planting, and a day or two before setting out the plants or after sowing the seed scatter the bait broadcast over the ground late in the evening so that the worms will feed upon it and be killed, and the plants thus saved.

Caution.—Remember not to let livestock, including poultry, have access to the bait either when stored or after being scattered in the field ; also wash out well all vessels used in making it.

4. If the cutworms are of the underground feeding kind which attack the roots it will be necessary to drill the bait into the ground two or three inches deep. In this case it should be mixed dry and shorts or middlings substituted for bran, as these make it go through the drill better.

5. Seed-beds may be protected the same way as open spaces by scattering the bait over them thinly.

Wherever there is a great outbreak of cutworms or army worms and they have begun to march forward, the poison bran bait scattered for a few yards all along in front of them will usually destroy them, though occasionally they will pass over it. In that case a furrow, or better two parallel furrows a yard or two apart, should be run ahead of them and the sides pulverized by dragging a log about ten inches in diameter and six feet long up and down the furrow. Cutworms can go up the firm side of a furrow but cannot climb over fine loose earth near the top, as this falls back under their weight. Poison baits should always be scattered along in these furrows. The furrows themselves should be at least six inches deep and should be ploughed carefully.

Usually any outbreak can be controlled completely by the combination of the dust furrow and of the poison bait, but it is seldom that the furrow will be needed.

GRASSHOPPERS

It is only where vegetables are grown in the vicinity of old pastures, old meadows, waste lands and roadsides that grasshoppers are likely to do any damage to them. This is because it is only in such places that our injurious species breed in large numbers.

There are many kinds of grasshoppers, some large and some small, but the only ones very troublesome in this province are:—the red-legged grasshopper (*Melanoplus femur - rubrum* De Geer), the lesser migratory or Mexican grasshopper (*Melanoplus atlanis* Riley), and the roadside or clear-winged grasshopper (*Cammula pellucida* Scud). These are all small, 1 to 1¼ inches long, and all have the same general habits.

Life History.—All three species have a similar life history: The winter is passed in the egg stage. The eggs hatch in May. The nymphs or young grasshoppers feed upon grasses, grains, or other green plants, and change into winged adults in June and July. The adults feed the rest of the season on the same kind of plants as the nymphs but wander more widely. Soon after this stage has been reached, the females begin laying eggs and continue to do so at intervals until killed by the frost in autumn. The eggs are deposited chiefly in meadows, pastures, waste lands and roadsides, and are enclosed in little pod-like structures made just below the surface of the ground by the females. These pods are lined and covered by a mucilaginous substance which holds them in place and protects them from the weather.

Control.—1. If the breeding places mentioned above can be ploughed late in fall and thoroughly worked early in spring, this will kill young eggs and prevent most of the young which hatch from reaching the surface.

2. If such lands are put into a short rotation of crops there will be no need to fear damage from grasshoppers.

3. Outbreaks can be controlled readily by the use of the following poison bait:—

Bran	12 lbs.
Sawdust, preferably fine	an equal bulk to that of bran
Fine white arsenic or paris green	1 lb.
Salt	1 lb.
Water	about 2½ gals.



Fig. 9.—One of our common grasshoppers, natural size.

Keeping the above proportions mix together with a scoop-shovel first the bran and the poison; then add the sawdust and mix well. The mixing can be done best on a clean cement floor or on a tight-fitting board floor. Dissolve the salt in the water, then pour the liquid on the above mixture and mix until every part is wet and will fall freely through the fingers.

If sodium arsenite liquid can be secured, it is preferable to paris green or white arsenic as it kills more quickly, and by being poured into the water and

stirred it gives a more uniform poisoning of the whole bait. Moreover, as it is a liquid, there is no danger of the operator being poisoned or injured by the dust when making up the bait. One pint of sodium arsenite liquid is about the equivalent of 1 pound of paris green or white arsenic.

Apply the bait between 6.00 a.m. and 4 p.m. on a bright, warm day, not on a cold, wet or dark day. Grasshoppers feed most at temperatures between 75° F. and 85° F., not higher or lower. The above amount is sufficient for at least two acres of infested land. An easy way to apply it is to draw the required amount to the field on a stoneboat or wagon, then using a large pail scatter it by hand like seed grain very thinly over the infested fields or roadsides or wherever the grasshoppers are present. It is possible to sit in a rig and scatter the bait as one drives along. One application is sufficient as a rule, but sometimes a second a few days after the first is desirable. The bait will kill nymphs as well as adults and should be applied as soon as the insects are seen to be numerous enough to justify treatment.

Caution.—Do not allow cattle, poultry or livestock of any kind to have access to the bait. There is usually no danger to cattle or other livestock, except perhaps poultry, once it has been scattered over the field, if this has been done thinly.

WHITE GRUBS (*Phyllophaga*)

White grubs are the large, white, curved grubs which live in the soil and attack the roots of many kinds of plants and bore into the tubers of potatoes. The grubs have brown heads, three pairs of long legs, and the body curved almost into a circle. When full-grown they are about 1 1/3 inches long and about 1/3 inch thick. They are the larvae of the large, stout, brown beetles known as June beetles or June bugs which fly around in late May and June on warm, calm nights, and at times are attracted into our homes by the light.



Fig. 10.—White grub and adults—June beetles. (J. Marshall.)

There are about a dozen common to fairly common species of these insects in Ontario, all of them belonging to the genus *Phyllophaga*, but as all of these have very similar life histories and habits we shall consider them as one.

Injury.—White grubs are among the most destructive of our common farm insects. Both the beetles and the larvae are injurious. The former feed at night upon the leaves of several kinds of trees, especially elm, ash, poplar, oak, and hickory; and when abundant may completely defoliate them. The grubs feed a short distance below the ground on the roots of grasses, timothy, wheat, barley, oats, rye, corn, strawberries, young seedling trees in nurseries or elsewhere, and many other plants. They also, as said above, attack the tubers of potatoes and at times bore into fleshy roots such as beets and carrots. It is not uncommon to see corn fields, or pastures, or timothy

meadows with large dead patches caused by these insects. Severe injury to potatoes is also very common. Moreover, lawns, golf courses and cemeteries sometimes have much of their grass destroyed. Fortunately the insects, according to Mr. George Hammond of the Entomological Branch, Ottawa, who has made a careful study of them for several years, cause almost no damage to plants on clay soil, but are limited largely to sandy or open-textured soils in which the grubs can move about with comparative ease. It has been known for many years that sweet clover, alfalfa, red clover and alsike are largely immune to attack, and that peas are seldom severely damaged. Wheat, barley, oats and rye, though subject to attack, are somewhat more resistant than corn, strawberries, potatoes and some other plants.

Life History. Most of our insects pass through all stages of their life in a single year or even less time, but white grubs require three full years to do so. A knowledge of their life history helps greatly to explain the time when they do most damage and also why certain control measures are used. The beetles emerge from the soil in late May and June, and fly around on warm nights during this period. As already said, they feed on the foliage of trees, one species preferring one kind of tree and another another. During the day the beetles hide in the grass or other cover. Soon after emerging egg-laying commences. The eggs are globular and white and are laid in the soil chiefly in old pastures, timothy meadows, roadsides and waste lands. Eggs apparently are never laid in bare land and only seldom in good stands of clover or alfalfa. They hatch in two to four weeks. The young grubs at first are very small, but by fall are about half an inch in length and of the same shape as the full-grown larvae. This first year of their life they do relatively little damage, partly because they are small and partly because part of their food seems to be decaying organic matter in the soil. In October the grubs go down into the soil to a depth of about 10 or 12 inches. Here they remain until the soil warms up in May, when they come up near the surface again and begin feeding on the roots of plants. By far the greatest damage is done this year because the grubs are now larger and by fall are nearly full-grown. In October they again go down about a foot into the soil and again come up the next May. This third year they feed only for a short time, then cease to do so and prepare to pupate. Pupation takes place in an earthen case in the soil in July and August, and lasts about one month. Then the pupa becomes an adult beetle. Instead of coming out of the soil and flying around in the fall the beetles remain underground until the next May or June. Often in ploughing in late fall or early spring these beetles are turned up to the surface. We see, therefore, that three full years are required for the life history and that it is only in the next year after the flight of the beetles that serious damage is done. This should be kept in mind when considering control measures.

Control. (1) Experience has shown that there is little or no damage from white grubs on farms on which a short rotation of crops is followed, especially if clover of some kind is used as one of the crops in this rotation. The chief reason for this is apparently that such a rotation removes the natural breeding places for the insect.

(2) If ploughing sod in the fall or spring reveals that there are many white grubs present, corn or potatoes should not be planted in such fields. Plant instead oats or barley or a mixture of these, using a little more seed per acre than usual; and at the same time seed the field to red clover, alsike or sweet clover. Next year harvest the clover or pasture it off or plough it under as a soiling crop. After this any kind of crop may safely be planted.

It should be remembered, however, that strawberries should never be planted in any field that is even lightly infested by white grubs.

(3) If a field happens to have been sown with grain or other crop and this is destroyed early in the spring by the grubs, the best plan usually is to disc the soil at once deeply about three times in each of two directions, as this kills most of the grubs; then sow buckwheat at the usual date. This crop grows quickly and will usually thrive and mature in spite of the grubs.

(4) If in pastures or meadows the grass or timothy is killed out in large patches here and there it is a good plan to disc deeply and frequently and then reseed at once with grass or timothy. If rain comes or the soil is moist this will soon germinate and cover the bare areas. If the whole field is too much injured to treat as above it will probably be wise to plough it about three inches deep and then disc it to that depth five or six times to kill the grubs; or, if hogs are available, they may be allowed to run in the field and will root out and kill the grubs. A green pasture mixture such as oats and barley combined or even rape may then be sown, if the soil is moist enough for germination. If pasture is not needed the field can be summer fallowed and wheat sown in fall.

(5) When lawns, cemeteries or golf courses are being attacked by white grubs, usually the best method of control is to dust arsenate of lead over the surface of the infested areas when the grass is dry, and then water this in with a hose or sprayer or other device, if heavy rains do not do this for you. The arsenate of lead is used at the rate of 6 lbs. to 1,000 sq. ft. of surface, and to make it easier to spread this uniformly it should first be mixed with about 4 times its own bulk of sand or fine earth. This poison is not effective until it is washed down into the soil where the grubs will devour it when feeding on the roots.

(6) In conclusion it is well to keep in mind that weak plants are more easily killed than vigorous plants; hence fertilizers can sometimes be used to advantage, and both fertilizer and watering when needed will help in golf courses, cemeteries and lawns.

It need scarcely be added that in small gardens, if only a few plants are being attacked, the grubs may be found by digging, and destroyed.

WIREWORMS

Wireworms, as the name suggests, are hard, slender, cylindrical or nearly cylindrical worms. There are several species, the colour and size varying with the species. One, known as the wheat wireworm (*Agriotes mancus* Say.), though it attacks other kinds of plants besides wheat, is glossy, pale yellow or straw colour, and when full-grown is about 1 inch long. Another common species, the corn wireworm (*Melanotus communis* Gyll.), which also attacks many kinds of plants, is light reddish-brown and about 1¼ inches long. All the other common wireworms in this province resemble closely one or other of the above two.

The adults are called click beetles, because, if placed on their backs, they spring up into the air with a clicking sound. They vary in size, some being about 1/3-inch in length, others nearly 1 inch. The colour is brown or blackish. The general shape is shown in figure 12.

Millipedes are often mistaken for wireworms, but may be distinguished



Fig. 11—Millipedes, natural size. Note the large number of slender legs all along the body and the habit of curling up when at rest.

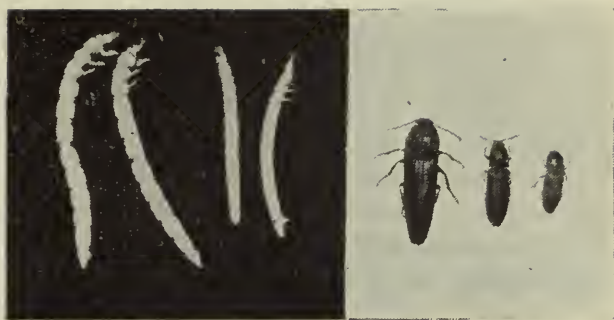


Fig. 12.—Two common species of wireworms and three species of adults, all natural size.

easily by the fact that they have numerous legs along the under side of the body, whereas the wireworms have only 3 pairs of legs.

Food Plants.—Wireworms attack a wide range of plants, including almost all cereals and grasses, not excepting couch grass, and most vegetables. Legumes, including red clover, sweet clover, alfalfa and peas are seldom severely attacked. The same is true also to a considerable extent of buckwheat and flax.

Injury.—The beetles feed upon the blossoms of many kinds of plants and also upon sweet substances wherever they can find them, but in Ontario do almost no harm. Hence it is the wireworms themselves which do the damage. These, as mentioned above, attack numerous plants, but most complaints have been received of injury to potatoes, tobacco, tomatoes and corn. Potatoes are injured chiefly by the larvae boring into the tubers and making tunnels in them. They may even continue to work when the potatoes are stored for winter, if the temperature is about 60° F. Tomatoes and tobacco may be injured either by the roots being eaten off or by the wireworms boring up through the stems and killing the plants. Corn seed in the soil is often fed upon to such an extent that no plants are produced, but even when the plants have appeared they may be killed by the roots being devoured. In addition to the above four plants it is not uncommon for such crops as oats, barley and wheat to be destroyed or seriously injured, if the wireworms are numerous. This seems to take place to a greater degree in a cold backward spring when the plants are making little or no headway while the wireworms are quite active. In brief, we may say that wireworms are among the most destructive of all insect pests of the farm.

Most species do little or no damage in this province wherever a short rotation of crops and good clean farming methods are practiced. This is because they breed chiefly in land that has been in sod for several years. The first year after breaking up such sod the wireworms often do little harm to the new crop, with the exception of potatoes, which may be seriously injured at times. This is probably because they find all the food they desire the first year in the decaying sod itself. The second year, however, there is no decaying sod left to feed upon and so they attack the new crop, if susceptible, and do serious damage. Damage may continue to be done for one or two years longer, but usually not to so great an extent as in the second year.

While most species of wireworms breed in old sod land we have at least one species which breeds in well cultivated lands and which is at times troublesome, especially in private gardens and land devoted to vegetable growing. Fortunately this species is not nearly so common as the sod-breeding type.

Life History.—The life history of wireworms is very similar to that of white grubs. The adults come out of their winter quarters usually in April, and can be found throughout May and most of June. Eggs are laid in the soil, chiefly in grass lands or very weedy land. We have not full data on the eggs but those of several species at least are round, glossy, white and hatch in two to four weeks. The larvae the first year, as said before, do little harm, as they feed mostly upon the decaying sod itself. In October they go below the plow line, though some seem to remain above it at times. The next spring when the ground is ready to plow and plant they come up, and this year, because of their larger size and of the disappearance of decaying vegetation, feed upon the seeds or the roots of the living plants and do great damage. In October they again go down into the earth. Next spring they come up and resume feeding for a few weeks. In June they cease feeding and make an earthen case in which to pupate. Pupation occurs in either July or August and this stage lasts about one month. The pupa then changes into the adult which remains in the earthen case, like the June beetle, until the next spring. It may be mentioned here in passing that breaking the pupal case by plowing in July or August will kill most of the pupae and many of the new adults. The same is true of the pupa and new adults of white grubs.

The above is the life history of the common so-called wheat wireworm, but the corn wireworm and some other species seem to have a longer life history, and to remain as larvae not for two years only, but for three or four years. Therefore, after breaking up an old infested sod, it will require longer to free the soil from these than from the wheat wireworm.

The less important species, mentioned above as laying eggs in cultivated soil, has only a one-year life cycle.

Control. 1. The chief method by which farms and gardens are kept free from wireworms is by practising a short rotation of crops and clean farming. This removes the main breeding places, namely, the old pastures, meadows and couch grass. When breaking up such a field a good practice to follow is either to plough it early, work it up and sow wheat the same fall or, if this cannot be done, plough it later in the fall, and next spring sow oats or barley. In either case put in red or sweet clover in the spring. Next year take off the clover, plough early and put in wheat, adding a clover again the following spring; or oats or barley with a clover may again be used. After this crop of clover has been harvested or ploughed under usually any crop may follow.

Peas, buckwheat and flax being, like clover, very little attacked by wireworms may also be used in the rotation until the soil is free from the worms. Alfalfa, too, is seldom injured but does not work well into a rotation.

Corn and potatoes being very susceptible should never be planted in any soil which is known to contain wireworms to any appreciable extent.

2. It has been observed that wireworms are usually worse in poorly drained soil; hence tile draining will often help greatly. Liming of wet soils, which are usually acid, will probably also be of value, at least in assisting plant growth.

3. The more rapidly the plants grow, especially in spring, the less likely they are to be killed by wireworms; hence before planting the field prepare

the soil well and, if poor, add commercial fertilizer and lime where needed. Do not plant the seed deeply.

4. Baits may sometimes be used on a small scale, especially in gardens and greenhouses, to capture the wireworms. Potatoes placed about 3 inches deep in the soil and 10 feet apart make a good bait. Stick a short wire painted white into each potato to mark its position. Examine the potatoes once a week and destroy the wireworms present. Replace the potatoes and repeat. This may be done for three weeks in succession and will result in getting rid of many of the wireworms. It should be begun in spring as soon as the ground is warm and the wireworms have come up, as can be determined with a shovel.

Baits of moistened bran and flour kneaded into balls, or of wheat or corn, may be substituted for potatoes. In that case they will not be removed, but the worms will merely be picked out of them and fresh material, if necessary, added each time.

5. When potatoes are seen to be attacked it is usually advisable to harvest them early as this will remove them from most of the wireworms and so lessen the amount of damage that would otherwise be done.

6. If a farmer knows that there are a considerable, though not a great number of wireworms in his soil, and yet is determined to risk planting tobacco in it, it would seem worth while trying baits on at least part of the field. The baits in this case might consist either of corn kernels planted with a hand planter at the rate of about a dozen kernels set 3 inches deep between every two tobacco plants, or of one or two potatoes set at the same depth. The corn or potatoes would probably attract many of the wireworms and could be left until destroyed by cultivation. They should give the tobacco plants a better chance to get a sufficient root system to be able to withstand the wireworms.

Useless or impracticable remedies.—Neither salt nor gas-lime will kill wireworms unless applied heavily enough to ruin the crop. Lime itself has no effect upon them, except that sometimes it may be valuable in promoting better growth. Strychnine, arsenic, corrosive sublimate or any other known poison which might be put on baits will not kill them. Covering the seed with coal tar or gas tar cannot be recommended, as it often prevents germination and usually fails to keep off the worms.

SLUGS

There are several species of slugs. Our most common one is grey in colour, tapers gradually towards both ends, has a soft, slimy body, moves slowly and leaves behind it a trail of slime. When full-grown it is about $1\frac{1}{2}$ inches long and $\frac{1}{3}$ to $\frac{1}{2}$ inch in diameter.

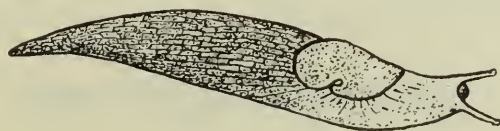


Fig. 13.—Common grey slug. (R. Ozburn.)

Slugs have sharp biting mouthparts with which they can eat holes out of leaves or, by starting at the edge, gradually devour the whole leaf itself.

They feed at night or in late evening or early morning. Moisture is a necessity to them; so they shun the daylight and dry air by hiding under

leaves or beneath the surface of the ground. They are regularly most abundant and destructive in wet seasons.

Food Plants and Injury.—In a wet spring the foliage of beans and corn is often severely attacked and sometimes much of it eaten. In addition the slugs are fond of feeding upon lettuce, cabbage and cauliflower and eat large areas out of the leaves of these. They feed to some extent on almost any vegetable and in fall are often found boring into tomatoes, beets and carrots. In dry seasons they usually cause very little damage.

Life History.—The winter is passed chiefly in the egg stage in the ground. The eggs are roundish, bluish-white, jelly-like and translucent. They are laid either singly or in small clusters. Another form in which the winter is sometimes passed is as adults hidden in the soil, especially in well-protected places such as are afforded by dense vegetation. Cold winters kill a large percentage of both eggs and adults. The eggs hatch in spring, about June. The young slugs become full grown about August, and in September and October eggs are laid. There is only one generation a year.

Control.—When slugs are attacking plants the simplest method of control in most cases is to dust hydrated lime around the base of the plants. In going through this they get the lime on their body and are destroyed. The dusting will have to be repeated after a rain, because rain soon spoils the effectiveness of the lime. Another method sometimes used to good effect is to chop up lettuce or clover leaves into small pieces, dust these with calcium arsenate at the rate of 16 parts by weight of leaves to 1 part of the poison, and then place little piles of these in the evening here and there wherever the slugs are likely to be. Hawley* found that merely keeping plants well sprayed with Bordeaux mixture gave a large degree of protection. It is probable dusting with Bordeaux dust would also be effective. Some persons use the same bait as recommended for cutworms against them. See page 12.

As slugs may come into the garden or vegetable plot from the surrounding areas where there is long grass, dense weeds or rubbish, which afford good hiding and breeding places, it will sometimes be a help to place a narrow barrier of hydrated lime or salt between such places and the nearby vegetables to be protected. It is also a good plan in the fall of the year soon after the vegetables are harvested to clean up and burn all rubbish and plant remnants, and to scatter liberally over the bare ground hydrated lime, or moisten the surface well with a solution of corrosive sublimate of the strength of 1 oz. to 6 gals. of water. To dissolve this material place the required amount in a wooden or glazed earthenware vessel; add a little boiling water; stir to crush all lumps and make a thin paste; then add about half a gallon of the boiling water to every ounce of the corrosive sublimate and stir until all is dissolved. Metal vessels should not be used as the poison corrodes them.

Caution.—Corrosive sublimate is poisonous if taken internally, so keep it in a container marked POISON and be sure to wash out thoroughly all vessels after using.

TARNISHED PLANT BUG

Lygus pratensis Linnaeus.

The tarnished plant bug is a very common brownish insect about one-quarter of an inch in length and of the form shown in the accompanying figure. The nymphs are green or yellowish-green, and in their earlier stages look a good deal like aphids but are much more active and when disturbed quickly

*Memoir 55, Agr. Exp. Sta., Cornell University, Ithaca, New York.

seek shelter. Both adults and nymphs have very fine, sharp, piercing mouth-parts with which they penetrate the tissues of their host plants and extract the juices. When feeding they inject a poison into the wound and thereby increase the injury.



Fig. 14.—Tarnished plant bug adult, enlarged about four times.

Food Plants.—A full list of the food plants has never been made but the insect is known to feed upon so many different cultivated and wild plants that it may be said to be almost omnivorous. Some of its favourites are mullein, pigweed, golden rod, aster, dahlia, chrysanthemum, celery, beet, strawberry and young peach trees.

Injury.—The greatest damage is usually done to cultivated flowers which bloom in late summer and autumn, especially asters, dahlias and chrysanthemums. So common is the insect on asters that it is often called the “aster bug.” The adults do most of the damage. They puncture the unopened buds, especially the flower buds, and suck the juices, at the same time inserting a poison. The result is that many of the buds are killed outright and the bloom on many others is distorted and rendered worthless. The plants themselves also often become stunted and bushy as a result of punctures in their tissues. Celery is also much injured: the adults in July and early August gather from weeds, especially pigweed, and other plants in the vicinity and puncture the celery stems here and there, causing them to turn brown at the affected places. In addition both adults and nymphs attack the heart of the plant and by their feeding cause similar killing and browning of tissues there. The result is that soft rot frequently gets entrance into the injured heart tissues and the whole inner and most valuable portion of the plant becomes a slimy rotten mass. In 1929 several very promising celery plots were almost totally destroyed in this way, thus causing a loss of several thousand dollars.

On strawberries the immature fruits are fed upon by the adults, with the result that they are either killed or produce one-sided or “buttoned” fruit. When beet leaves are attacked they become crinkled and dwarfed. Young peach tree buds and tender terminal growth are often punctured and killed. Trees thus attacked are forced to produce lateral branches and thereby become bushy and hard to shape properly.

Life History.—The winter is passed in the adult stage under leaves, long grass and other kinds of rubbish, a favourite wintering place being in woods or thickets or along hedges, where the fallen leaves afford excellent protec-

tion. Early in April the adults come forth from winter quarters and feed at first upon the buds of fruit trees, and shrubs, and the green crowns or leaves of biennial and perennial plants, and then upon the early annual plants. Later, when more succulent or more favoured plants appear, they leave the less attractive and fly to these. Egg-laying begins early in May and continues



Fig. 15.—Soft rot in celery heart, following upon injury by the tarnished plant bug. All the black area is rotten. The rot often extends much farther down.

until near the end of June. The eggs are flask-shaped and are inserted into the petioles and midribs of leaves, or into buds or flower heads, or soft fleshy terminal growths of numerous host plants. They hatch in about 18 days.

The nymphs, as stated above, are greenish or yellowish-green, and usually have four black spots on the thorax. They have the same general feeding habits as the adults. The nymphal stage lasts about 38 days, and the total life-cycle from egg to adult is almost two months. New adults begin to appear early in July and continue appearing on into August. They soon mate and commence egg-laying for a second brood of nymphs, which begins to appear late in July and continues to do so throughout August and early September. This brood of nymphs becomes mature during late August, September and October and the adults from them go into winter quarters in October and November. There are only two generations a year.

Control.—A control for the insect on celery has been discovered and well

tested in New York State. This consists in either dusting or spraying the plants with a mixture of sulphur and hydrated lime. As a dust use 25 lbs. of fine orchard-dusting sulphur mixed thoroughly with 75 lbs. of hydrated lime. If the weather is moist and there is danger of blight, add 10 lbs. of fine mono-hydrated copper sulphate to the above and see that it is well mixed. The dust should be applied with a power duster and must be driven right down into the hearts of the plants, where most of the damage is done. For this reason the nozzles or outlets should be set directly above the rows and close to the plants. The amount of dust required depends partly on the size of the plants and partly on how far the rows are apart. Where the rows are wide apart 60 to 100 lbs. per acre seems sufficient. When the rows are close together 80 to 150 lbs. per acre are required. Hand dusters are too slow and have not sufficient pressure to drive the dust well into the hearts and thus should not be used unless absolutely necessary.

Spraying has been found to give just about as good results as dusting and may be more convenient for some growers. The proportions of the sulphur and lime here are 15 lbs. of a fine wettable sulphur of the type sold by spray companies for spraying fruit trees, and 30 lbs. of hydrated lime, to 40 gals. of water. This mixture must of course be kept well agitated. If there is danger of blight, dissolve 3 lbs. of copper sulphate and add it to the spray. The spraying should be done with a power outfit and the nozzles so set that the mixture will be driven right into the hearts. If the rows are wide apart, 60 to 100 gals. per acre should be sufficient. If the rows are close together, use 100 to 150 gals.

Dusting should be done only when there is no wind and preferably when there is some dew. A good time is in the evening. Spraying may be done at any time of the day, but a calm day is better than a windy one.

The time to make the first application of either dust or spray will depend upon when the bugs begin to attack the plants. The best plan probably is to inspect the earliest celery every two or three days after July 1st and, as soon as the bugs can easily be seen on the plants and are at all common, apply the treatment. In fine weather applications should be given about 10 or 12 days apart; in wet weather they should be applied after the rain and at intervals of about 7 days, or whenever the bugs are seen to be getting at all numerous again.

We have had only one opportunity to test out this new method of controlling the tarnished plant bug and on that occasion it gave good results. In New York State it is said to be very popular. We would advise any grower who is troubled with these bugs to try it.

Unfortunately no really good control method has yet been found for tarnished plant bugs on asters, dahlias and other plants. It will always help, however, if late each fall all rubbish and leaves in and around the garden are gathered and burned, thus destroying the natural winter quarters of the insects. Keeping down weeds in spring and early summer in the garden itself and as far back on all sides as practicable, will also help, because the plant bug feeds on these until the flowers or other cultivated plants have reached the attractive stage, when they desert the weeds and come to them.

Some entomologists claim that certain pyrethrum sprays will kill these insects. We have not tried all kinds, but those we have tested failed to do so. They stupefied the insects for a time but all recovered. The same was true of all nicotine sprays and dusts, even when used much stronger than usual.

INSECTS ATTACKING ASPARAGUS

ASPARAGUS BEETLE

Crioceris asparagi Linn.

The asparagus beetle is a brilliantly coloured insect about $\frac{1}{4}$ -inch long. The general colour is bluish-black. The thorax is red and the wing covers dark-blue marked with lemon-yellow and bordered with red. The larvae are dark-brown, grey, or olive-grey with black heads and legs. The body is usually held in a curved position when feeding. The length when full-grown is $\frac{1}{4}$ to $\frac{1}{3}$ of an inch.

The insect is widely distributed over the province, but fluctuates greatly in numbers, some years being very abundant and causing heavy losses, other years being so scarce that almost no damage is done.

Injury.—During the cutting season the adults attack the young shoots almost as soon as they come through the soil and, if very numerous, make many of them unmarketable by eating holes here and there, and laying numerous dark conspicuous eggs on the surface. They also feed upon the young seedlings in freshly planted beds and injure these even more seriously than the shoots in the commercial beds. After the cutting season is over both



Fig. 16.—Asparagus beetle—(a, a) adults; (b) eggs; (c, c, c) larvae about full-grown; (d) pupal case, all natural size.

the adults and their larvae attack the leaves, branches and even the green surface of the stems themselves, and in a severe outbreak devour all the green parts, leaving the plants brown and bare as if struck by some devastating blight or severe frost. The plants, however, are not killed because the roots have not been touched, but they are greatly weakened and the new shoots the

next spring will be weak and small. Fortunately serious outbreaks with great losses are rare. We have only had about three or four during the last 15 years. Some years the beetles are so scarce that there is practically no loss.

Life History.—The winter is passed in the adult stage, the beetles hiding in sheltered places, usually near the asparagus plantation, such as in holes or crevices in logs or stumps, under loose bark on trees or beneath clusters of leaves and rubbish of various kinds. In spring about the time the asparagus plants begin to send up shoots through the soil the beetles commence to leave their winter quarters and proceed to attack the young shoots. Egg-laying begins in a few days and continues for several weeks. The eggs are dark brown, about three times as long as wide and are attached at one end to the shoots in spring and later on in the season to the leaves and branches. There is usually a row of several eggs together. The incubation period varies from about 5 to 10 days. The larvae grow rapidly and are full size in 7 to 16 days. They then drop to the ground, work their way a short distance below the surface and pupate in little finely woven cocoons covered with earth. The period spent in the soil before the adults appear varies from 7 to 18 days. Thus the whole time from egg to adult may be passed in less than a month though it averages about a month. Some seasons the new beetles begin to appear by the end of June. There are at least two generations a year throughout the whole province and probably three or at least a large portion of a third in the warmer districts.

Control.—1. The asparagus plots should be well cultivated and well fertilized. This results in the plants growing rapidly, allows cutting to be done frequently enough so that the beetles have little chance most years to injure the shoots during the marketing season, and prevents most eggs that may have been laid from having time to hatch.

2. Gathering and burning all rubbish in the vicinity of the asparagus plantation each fall will help to lessen the number of the beetles the next spring, because they winter over in or beneath such materials.

3. Poultry, if allowed to run among the asparagus plants, will devour many of the beetles and their larvae.

4. When, as sometimes happens, the beetles are exceedingly numerous in spring and are destroying the young shoots or making them unmarketable, the best method of control so far discovered is to dust the plantation with pulverized cyanamid at the rate of 300 to 350 lbs. per acre. This not only kills or drives away the beetles, but also acts as a fertilizer and does much to control weeds without injuring the asparagus.

5. Seedling plots as soon as attacked and the older plots as soon as the cutting season is over, should be thoroughly dusted with either calcium arsenate or lead arsenate mixed thoroughly with hydrated lime at the rate of 1 lb. of the poison to 6 lbs. of hydrated lime; or they should be sprayed with 1½ lbs. arsenate of lead and 2 lbs. of soap or soap powder to 40 gals. of water. Instead of the soap ¼ lb. of skim milk powder and ¾ lb. of hydrated lime, or ½ lb. of fresh calcium caseinate or ½ lb. of soy bean flour may be used. The spraying or dusting should be repeated when required until all the beetles and larvae have been destroyed. If this were done by all growers in the district there would be very few beetles the next spring.

Damage to the plants from breaking them down during the spraying may be largely prevented by the operator standing on the tank and spraying as

many rows as possible as the machine goes up the row, or by fastening a boom such as a long pole by one end to a pivot or swivel on the rear of the top of the tank and attaching the hose along this. The boom will thus hold the hose above the asparagus and one man by swinging it gradually from one side to the other can cover 50 feet or more each time the machine goes up or down a row.

TWELVE-SPOTTED ASPARAGUS BEETLE

Crioceris duodecimpunctata Linn.



Fig. 17.—Twelve-spotted asparagus beetle—adult enlarged; the line to the right shows natural length.

The twelve-spotted asparagus beetle is very similar in size and shape to the species just described but can be distinguished easily from it by its red colour and the 12 black spots on its wing covers.

The larvae are about the same size and shape as those of the asparagus beetle, but instead of being grey or brown are yellowish-white to brownish-yellow or orange. They feed inside the asparagus fruits and so are seldom seen.

Injury.—The beetles injure the plants by feeding upon the shoots during the cutting season and later upon the leaves and branches in the same way as the other species, but usually are not so abundant.

The larvae do practically no harm as they feed inside the berries on the pulp. A single larva may attack several berries.

Life History.—The life history of this species is very similar to that of the asparagus beetle. The main difference is that the eggs are apparently not laid until the berries have at least begun to form and that the larvae live inside the berries. The eggs are elongate, dark green, and are attached by the side to the branches of the plant. The lateness of egg-laying results in the new generation of beetles appearing later than that of the other species. In 1926, in Elgin county, emergence of the beetles from the soil was just commencing on August 11th and large numbers were still in the pupal or larval stage. As 1926 was a cold season, probably emergence would begin under normal conditions about August 1st. There are apparently two generations a year. The winter is spent in the same sort of places as the other species chooses.

Control.—The same control applies to this species as to the preceding species.

INSECTS ATTACKING BEANS

BEAN WEEVIL

Mylabris obtectus Say.

The bean weevil is a small, stout, somewhat wedge-shaped, yellowish-brown or olive beetle about $\frac{1}{8}$ inch long and $\frac{1}{10}$ inch wide at the broadest part of the body, namely, near the posterior end.

Food Plants.—Our common kidney beans are the favourite but lima beans and cow peas are also subject to attack.

Life History and Injury.—In Ontario the weevil seldom attacks growing bean plants but limits itself either exclusively, or almost exclusively, to stored seed. On this the beetles lay their eggs. The larvae on hatching bore into the beans and feed there until maturity. Each larva makes a separate chamber or cell for itself and a single bean may contain a dozen or more such chambers. In these, when full-grown, the larvae pupate and the pupae change to adults. When emerging, the adults remove the surface covering and thus leave the larval chambers exposed to view. Breeding goes on throughout the winter if the storage room is heated, but otherwise stops with the advent of cold weather. In warm buildings the insects may become so numerous as to reduce the beans almost to powder and thus make them a total loss.

Fortunately our winters are cold enough to destroy all stages of the insect whenever the beans are stored in barns or sheds or unheated buildings. This is no doubt the reason why it is only occasionally that stored beans are attacked in this province compared with what takes place in the warmer parts of the United States.

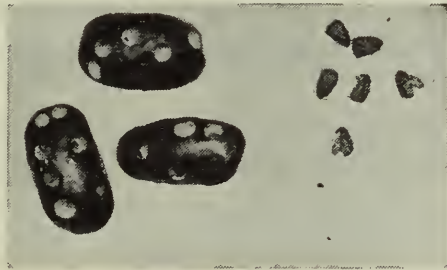


Fig. 18.—Bean weevils and their work, natural size.

Control.—1. Infested beans should not be planted, partly because there may be living beetles in them, and partly because many of them will not germinate.

2. In storing beans advantage should be taken of low temperatures. Therefore the beans should always be stored for winter in an unheated room, where the inside temperatures will correspond closely to the outside and will not only prevent feeding but actually kill all stages of the insects.

3. In the summer, or at any time when the temperature is 65° F. or higher, all stages of the pest may be killed by fumigating the beans with a fumigant that is heavier than air. Carbon bisulphide is the best known fumigant, but has the objectionable characteristic of being inflammable when mixed with air, and therefore is dangerous to use unless great precautions

are taken to keep away all fire. There are some good proprietary fumigating materials on the market which are not only effective but non-inflammable. For the address of the manufacturers write to the Department of Entomology, Ontario Agricultural College, Guelph.

Directions for Fumigating

The fumigation container may be a barrel, box, bin, or special chamber, but whatever it is the sides and bottom must be airtight; otherwise the gas will escape to such an extent that satisfactory results will not be obtained.

If carbon bisulphide is to be used the fumigation should be done, if possible, in barrels or boxes in the open. If it cannot be done outside, great care must be taken not to forget that a lighted cigarette, pipe, lantern, or even a spark from driving a nail may cause an explosion.

A temperature of 65° F. or higher is necessary in all cases to secure a perfect kill of the insects.

When putting the beans into the container for fumigation they should not reach higher than about 3 inches from the top. After they have been put in, the surface should be levelled before applying the fumigant and a cover made ready to put over the top. For a large container, as a bin, a heavy tarpaulin or several heavy blankets make a good cover; for barrels a double ply of wrapping paper or a double blanket or both is satisfactory. These should be tied on with a stout cord or held in place by an oversize hoop.

The amount of carbon bisulphide necessary is 1 lb. to every 30 bushels of the grain, or about 4 ounces ($\frac{1}{2}$ cup) to a 50 gal. barrel. When proprietary fumigants are used, directions will be provided by the manufacturer or dealer, but usually it is well to double the recommended strength to make sure of satisfactory results.

The method of applying a fumigant is to put the requisite amount into a pail or watering can and pour it as evenly as possible over the grain and then at once cover the barrel, or bin, or other container with the paper, blanket or tarpaulin mentioned above.

Fumigation should be allowed to continue for 48 hours, after which time the cover should be removed. The grain may then either be removed or left where it is.

Carbon bisulphide or proprietary fumigants do not as a rule injure the grain either for germination or for food.

In using either carbon bisulphide or a proprietary fumigant the operator should do the work quickly but carefully and should not remain among the fumes any longer than he can help lest he be overcome by them. It is wise also where there is a ceiling near the top of a bin to leave the doors and windows open until the cover has been put on. In all cases put up a sign—

Caution.—Fumigating; Danger; Keep Out.

SEED CORN MAGGOT OR BEAN MAGGOT

Hylemyia cilicrura Rond.

The seed corn maggot, or, as it is usually called in Ontario, the bean maggot, because it has done more damage in this province to beans than to corn, is a little white maggot about $\frac{1}{4}$ inch long when mature, which attacks and destroys both the bean seed in the soil in the spring and the young bean plants as they are coming through or soon after they have come through the soil.

The adults are olive-grey, two-winged flies about 1/5 inch in length. They look much like the cabbage maggot flies except for being a little smaller. The figure of the cabbage maggot adult on page 35 gives some idea of their appearance. The maggots also resemble the cabbage maggot but are a little smaller.



Fig. 19.—Work of seed-corn maggot or bean maggot on young bean plants. (After Gibson & Treherne.)

Food Plants.—There is a long list of plants and seeds in which the maggots have been found, but beans, corn and seed potatoes are the chief in this province. It should be kept in mind, however, that almost any kind of decaying organic vegetable matter in the soil is likely to attract the flies to lay eggs on it.

Injury.—It is usually only in a cold, wet spring when germination is slow and growth retarded that this insect causes serious damage. In such seasons the maggots destroy beans either by attacking and killing the seed before it can germinate or by working into the stems soon after germination and killing them. The injury seems to be worst where the beans have been sown in fields which were in clover, alfalfa or grass the previous year, the reason probably being that the decaying roots and stems of such plants attract the flies and cause many eggs to be laid in them even before the beans themselves are planted; then when the beans are planted the maggots from the above eggs attack the bean seeds and plants, often apparently in preference to the decaying roots of the previous crop. Experiments seem to show that commercial fertilizers containing organic matter such as tankage or blood-meal also attract the flies.

Poor drainage is favourable to maggot injury because the growth and germination in such places are slower.

Corn is injured much the same way as beans.

Seed potatoes are occasionally so infested by maggots as to be utterly destroyed.

Life History.—So far as known this insect winters over in the puparial stage, just as the cabbage and onion maggots do, in the soil where the maggots have been feeding. The puparia are about the shape of a grain of wheat and are brown or reddish-brown. From them in May, usually several days earlier than the cabbage maggot flies, the adults begin to appear. Eggs are soon laid and are usually placed on or in the soil where there is an odor of decaying vegetable or other organic matter including decaying seeds. Manure recently ploughed under is said to attract the flies. The eggs hatch in two or three days. The maggot stage requires about 11 days and the puparial stage about two weeks. There are apparently three generations or one full generation and two partial. Of these the first, which occurs in late May and June, causes nearly all the damage.

Control.—Growers should keep in mind that it is only in a wet spring when growth is backward that the maggot is likely to cause serious injury. Under these conditions the following recommendations should be of value:

1. Good drainage always helps as drained soil warms up faster.
2. There is little or no benefit to be gained by treating seed with kerosene, turpentine, tar or any other substance tested up to the present. None of them will protect it.
3. The more quickly the seed germinates, the less liable the beans are to injury; hence, sow only seed of high germinating power; prepare the soil well to warm it and to be in good shape to bring about rapid germination and growth; and sow the seed shallow, never deep, because the upper soil is warmer than the lower and therefore the seed in it will germinate more quickly.
4. Remember that there is more risk in sowing land broken up from sod, especially clover or alfalfa sod, than other land. In such cases, work the field up well early in spring to make a good seed bed and then if the weather is warm sow early; but, if it is wet and cold, postpone sowing until there have been several days of warm weather to heat the soil.
5. If early sown beans have been ruined by the maggot it is usually safe to work the field up again at once and re-sow, as by this date the majority of the maggots in the field will have ceased feeding.

INSECTS ATTACKING BEETS AND SPINACH

SPINACH LEAF MINER

Pegomyia hyoscyami Ponzer.

The spinach leaf miner is also called the beet leaf miner. It is a creamy-white maggot very like the cabbage and onion maggots but, instead of attacking the roots as they do, it makes mines in the leaves. The adults are grey, two-winged flies of much the same shape as the cabbage maggot fly but a little smaller. The grey colour and yellow legs will help to distinguish them from other flies, which might be found around the same plants.

Food Plants.—Spinach, chard, beets of all kinds, including sugar beets and mangolds, are the common cultivated plants fed upon. In addition pigweed and lamb's quarters are quite heavily attacked. A few other weeds are also attacked but to a much less extent. The miner in dock leaves is a different species.

Injury.—The injury is caused by the larvae making mines in the leaves, especially in June. The mined portion of the leaf dies and turns brown or white. As several larvae usually work in each mine and as there may be half a dozen mines in a single leaf when there is a severe attack, many plants may be killed. It is not an uncommon sight during such an outbreak to see whole fields of beets or mangolds with fully half of their leaves either dead or severely mined. Yet in spite of this a very large percentage of the plants, as a rule, outgrow the injury and give fair yields, though doubtless not so large as they would have given if there had been no miners. When spinach is severely attacked the crop is usually ruined, because no one wants to buy infested spinach leaves and the time necessary to select only the intact ones is too great to make it profitable to harvest the crop. Fortunately most years the insects are not abundant enough to cause much damage or anxiety. It is only about once in four or five years or even longer that they are very numerous.



Fig. 20.—Work of spinach leaf miner in beet leaves. (A. Wilkes.)

Life History.—The winter is passed in the soil, just as in the case of the cabbage maggot, in the pupal (puparial) stage. From this in spring the flies commence to emerge towards the end of May and begin laying eggs about the first of June. These are white and are placed on their side in small clusters, averaging about 4 eggs each, on the under surface of the leaves. They hatch in four or five days. The young larvae bore directly into the leaves and soon make a conspicuous mine. As there are often many clusters of eggs to a leaf there may be many mines and, as these frequently coalesce, the whole leaf may in this way be killed. When dissatisfied with a mine, a larvae commonly leaves it, migrates to another leaf and mines it. Often it leaves this second one and goes to a third, or even to a fourth. The larval stage lasts about two weeks, then the larvae leave the mines and pupate in the ground. From the pupae adults begin to emerge in approximately two weeks. There are apparently three generations a year, though the last two are only partial gener-

ations. The first generation is the one that causes nearly all the damage, natural control factors being sufficiently strong to prevent much injury from the second or third generation.

Control.—No really satisfactory control measures have yet been discovered. Spraying with nicotine or other substances fails to do any good, because the spray cannot penetrate through the epidermis of the leaf and reach the larvae within.

A number of growers have succeeded in avoiding injury by preparing their soil well as early as possible and then planting at once. This allows the plants to come up and be ready for marketing before the eggs have hatched or many of the maggots are large enough to cause noticeable mines. Wherever practicable this seems to be the best policy to follow.

It would doubtless help also to lessen the number of flies for the next year if pigweed and lamb's-quarters were cut and burned as soon as the larvae in the mines begin to be nearly full-grown, but before they have emerged and entered the ground. Up to this time these weeds would act to some extent as baits and lessen the number of flies ovipositing upon spinach, beets, or mangolds.

INSECTS ATTACKING CARROTS, CELERY AND PARSNIPS

CARROT RUST FLY

Psila rosae Fabricius.

The carrot rust fly larva is the little white or cream coloured maggot which often ruins carrots, and to a lesser degree parsnips, by burrowing into them, destroying the tissues and leaving rusty stains wherever it works. The larva is about $\frac{1}{3}$ of an inch long when full-grown, is very slender and has no legs and no visible head, though there is a pair of small black hooks at the smaller end which serve as jaws.

The adults are slender, two-winged, glossy, greenish-black flies about $\frac{1}{5}$ of an inch long, with yellow or yellowish-brown heads and legs.

Food Plants.—Carrots are the favourites, but parsnips are also attacked and to a lesser extent celery and parsley.

Injury.—All the injury is done by the maggots and takes place at two periods in the season (a) in spring in June and July and (b) in fall in late

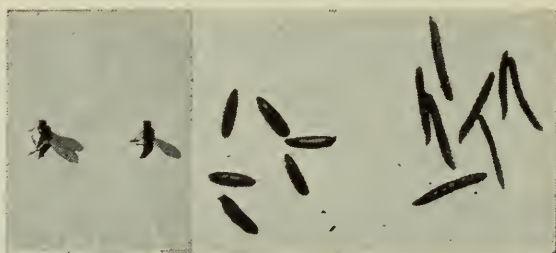


Fig. 21—Carrot rust fly—adults on the left, pupae in the centre, larvae on the right, all natural size. The larvae are not black as in the figure, but cream-coloured or white.

August, September, and October. The fall injury is nearly always much the more serious. In June the early brood of maggots attacks the young plants,

burrows into the tap root, and, if abundant, either kills the plants or checks their growth greatly. The attack is in full headway about the time the carrots are ready to thin. In fall the late brood attacks the carrot and parsnip tap-roots, which are of course well developed by this time. Narrow rusty-coloured furrows are made here and there over the surface, and tunnels through the interior. The tunnelling is usually most common towards the tip of the root, and this portion often becomes dark and rotten.

The injury to celery and parsley is brought about chiefly by the maggots attacking the roots. Usually the plants are vigorous enough to withstand the attack by sending out new roots. Where, however, several main roots are destroyed the plants often become stunted. The grower may not be aware that this is due to the maggots, especially as they seldom bore up into the saleable portions.

It is probable that in normal seasons the carrot rust fly prefers sheltered places, for most of the complaints of injury have come from towns and villages. Nevertheless, during heavy outbreaks even exposed fields may be heavily infested.

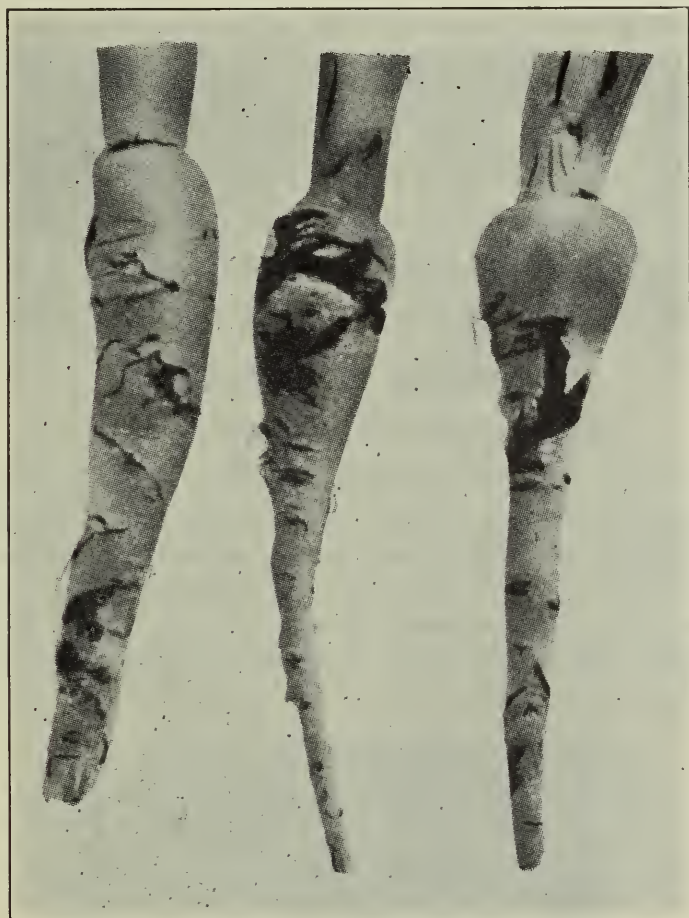


Fig. 22.—Work of carrot rust fly. The injured areas are usually rust colour. (After A. Dustan.)

Life History.—The winter is passed chiefly in the ground, near where the food plants were, in the puparial stage, the puparium being brown, about $\frac{1}{4}$ inch long and $\frac{1}{16}$ of an inch thick, and rounded at each end. Many of the maggots are still immature when the plants are harvested. These continue to feed and grow in storage and finally pupate there. The adults begin to emerge in the fields in May and continue to do so well into June. Egg-laying begins in about four days after emergence.

The eggs are very small, white and elongate and are laid chiefly in or upon the soil close to the food plants. They hatch in about a week and the maggots require nearly a month to become full-grown. At the end of this period they pupate in the soil. The new brood of flies emerges in August and early September and lays eggs for the second brood of maggots. These when mature pupate in the soil, as said above, and winter there. There are probably only two broods a year, though in New York there is a partial third generation which occurs in October and November.

Control.—It is doubtful whether in commercial plots it will pay to use any control other than to rotate carrots or parsnips with other crops and to plant them where they will be exposed to the wind, because it is only rarely that the insect is troublesome to any appreciable extent in such plots. If, however, the grower is afraid that he is going to suffer severe loss, the writer would suggest that at the end of August he pull up a few carrots here and there throughout the plot, and, if he finds a number of these are being attacked, harvest the crop at once before more eggs hatch and more larvae attack the roots. The carrots or parsnips should then, if only lightly attacked, be sold or stored in a cool place in soil taken from some spot where there could be no danger of its containing eggs or larvae.

Such substances as derris, naphthalene, corrosive sublimate and calomel have in experiments in a number of places given fair results, but the cost would usually be too high to justify their use, especially as it is difficult for the grower to know whether the insect would do any damage in any particular year, even if no control measures were taken. Moreover, most of the substances cause injury either to the foliage or roots of the plants and so lessen the yield.

PARSNIP WEBWORM

Depressaria heracliana DeGeer.

The parsnip webworm is the caterpillar that attacks the blossom heads of parsnips and carrots when allowed to grow for seed. It webs the blossom parts together and by feeding upon them prevents the formation of seed. Like most other insects it is much more abundant some years than others. The caterpillar when full-grown is about $\frac{3}{4}$ inch long; yellowish-green in colour, with a black head and many conspicuous black spots over its body. The adult is a brown moth of the size and shape shown in the illustration.



Fig. 23—Parsnip webworm—(a) adult with wings closed, natural position; (b) same with wings expanded; (c) larva full-grown; all natural size.

Life History.—The winter is passed in the adult stage in sheltered places, often in attics or barns. About June the moths lay their eggs on parsnips

and carrots grown for seed and also on wild carrots. The larvae on hatching work their way to the unopened blossom heads, eat into them, web the unexpanded blossom parts together and feed upon them. The result is that the blossoms cannot open properly and of course cannot produce seed. After feeding for nearly a month on the blossoms and neighboring leaves and becoming nearly full-grown the larvae crawl down the plants, eat a hole into the hollow stem, feed there a few days and then spin a cocoon and pupate within the stem. Many persons finding the larvae in such places mistake them for the European corn borer, but the black head and black dots on the body easily distinguish them from the corn insect. In August the pupae change into moths. These fly around for awhile and then go into winter quarters; so there is only one generation a year.

Control.—Heavy dusting of infested heads with paris green 1 part mixed with about 20 parts of land plaster or hydrated lime sometimes destroys a considerable portion of the worms, but at other times only a few. The difficulty is to get the poison forced into the webbed portion in such a way that the larvae will eat it.

2. Cutting off and destroying all infested heads as soon as seen is the most common method practised. This should be supplemented by the destruction so far as practicable of all wild carrots in the neighborhood. Even cutting these down as soon as they begin to bloom should help greatly to lessen the number of moths for the next year.

INSECTS ATTACKING CABBAGE, CAULIFLOWER, TURNIPS, RADISHES AND CLOSELY RELATED PLANTS

CABBAGE MAGGOT

Hylemyia brassicae Bouche.

The cabbage maggot is probably the most destructive insect which attacks cabbage, cauliflower and radishes. It is a small white maggot about $\frac{1}{4}$ inch long when full-grown. The body is blunt at one end and tapers gradually towards the other. There are no legs and no visible head, but a pair of black hooks at the smaller end of the body takes the place of jaws and tears apart the plant tissues, thus freeing the juices on which the maggot lives.



Fig. 24.—Cabbage maggot—female adult and eggs, the latter slightly enlarged.

The adults are two-winged flies about the size of a house fly. The females are greyish-brown or olive-brown; the males are darker, being a dark steel-grey colour.

Injury.—The maggots attack the roots of cabbage, cauliflower, radishes and several other closely related plants. In the case of the former two, the

injury is done, not only by the maggots devouring the small roots, but also by their feeding in the main tap-root itself and destroying it. The result is that the plants soon wilt and die. The early crop suffers much more injury than the late. Radishes are even worse attacked than other plants. The maggots work their way into them, make brown tunnels wherever they go and often cause much of the interior to rot. Wormy radishes are of course unfit for table use. Seed beds of cabbage and cauliflower, especially for late planting, are also often damaged severely.

During the last ten years shipments of turnips to the United States for table purposes has at times been greatly impeded by the maggots attacking them in late summer and in the fall, and tunnelling here and there over the surface or to a depth of half an inch or more. These tunnels are very conspicuous and unsightly and cause the affected turnips to be rejected by the buyers. Some years nearly half the crop is unsaleable and the loss to the growers is heavy.

Life History.—The winter is passed in the pupal (puparial) stage in the ground near the roots of the affected plants. The pupae are reddish-brown and resemble in shape and size plump grains of wheat. In spring about the



Fig. 25.—Work of cabbage maggot on cabbage roots.

time European plums are coming into full bloom the flies emerge and in 3 or 4 days begin laying their little, white, elongate eggs in the soil close to the stems of the plants. These hatch on an average in 5 days. The maggots

feed as described above and become mature in 2 or 3 weeks. They then pupate in the soil and in another period of 2 to 3 weeks, the new brood of flies begins to emerge. There are three generations a year, but only the first generation is a full one, as many of the pupae (puparia) of the other two remain unchanged in the soil until the next spring. The later broods, except on turnips, rarely do much damage.

Control.—Much the best method of control is to treat the soil around the base of the plants with corrosive-sublimate solution of the strength of 1 ounce in 10 gallons of water. Dissolve the corrosive sublimate by mixing it first with a stick in a little water so that it will be thoroughly wet and all lumps broken; then add more water and stir thoroughly until it is all in solution. It requires about half a gallon of water to dissolve an ounce readily. When all is in solution dilute to the proper strength. The liquid should always be applied to the plants shortly before or as soon as the eggs have begun to hatch; for it controls by killing the young maggots before the latter have entered the roots. Therefore, if cabbage or cauliflower have been set out very early, do not apply it until European plums are in full bloom, as very few eggs will have been laid until this time. If the plants are not set out until that date or later apply the solution the fourth day after planting and repeat in a week. Two applications are usually sufficient, but a few growers prefer to give three, the third being a week after the second. The poison should be poured directly on the soil right against the stem, using about $\frac{1}{3}$ to $\frac{1}{2}$ of a cupful to each plant. On small plots this may be done easily by carrying the mixture in a wooden pail and applying it with a cup or dipper. A handy dipper can be made from an empty tomato can by tacking a lath about 14 inches long to the bent-back lid and then squeezing the top to form a spout. On large fields a wooden barrel without any pump may be placed on a cart or wagon and filled with the solution, and two lines of soft rubber hose fastened to this. Then two men, one to each hose, can apply the liquid by walking along behind the outfit, pinching the hose between plants to prevent the escape of the liquid, and releasing the pressure at each plant. They should always take care to see that the soil is thoroughly wet for about an inch around each of the plants.

In the case of radishes, too, the corrosive sublimate solution should not be applied until European plums are in full bloom, if the radishes have been planted and are through the ground before that date. If the radishes have not come through the ground until after the plums are in full bloom, apply the poison on the fourth day after they appear above the ground. If, however, the weather is cold it will be wise to wait a day or two until it warms up, as the flies are not active in cold weather. Repeat the application in five or six days. A watering can with the knob or rose removed is a handy way to apply the liquid. Pour it along the rows right upon the plants, and wet the soil to a depth of half an inch or more. The radishes, of course, should be planted in rows to make treatment easy.

Caution.—Never treat radishes when they are nearly ready to use. It will do no good and may poison those who eat them; but there is no danger of poisoning if treated at the time mentioned above.

In treating cabbage and cauliflower seedbeds saturate the soil thoroughly by means of an ordinary watering can. Wash the can out thoroughly after using to prevent its being corroded, as corrosive sublimate will injure any kind of metal vessel though it does not injure wood. It is a good plan to paint the can first inside with a waterproof paint.

Caution.—Remember that corrosive sublimate is a deadly poison; hence be sure that none of it is left in any vessel where children or livestock may have access to it. Keep the substance itself labelled **Poison**. The antidote is to cause the patient to partake freely of white of egg or milk, and in ten minutes give an emetic.

IMPORTED CABBAGE WORM

Pieris rapae Linn.

The imported cabbage worm is a very common insect and is found in every garden or field in which cabbage is grown. When full-grown it is about one and one-eighth inches long, is about the same shade of green as the leaf, has an indistinct golden line down the back and when examined under a hand lens is seen to be densely covered with very short hairs dotted with black specks. This hairy covering easily distinguishes it, even when very small, from any other green caterpillar which may be present.

The adults are the white butterflies seen flying about every year. These have a wing expanse of about one and three-quarter inches. The wings are all white except a small black area at the tip of the front wings, two small black dots on the front wings of the female, and one on those of the male, and a single black dot on the hind wing of both sexes.

Food Plants.—The favourites are cabbage and cauliflower. Next to these are turnips, rape, brussels sprouts, broccoli and kale. In addition the caterpillars occasionally feed on various weeds and wild plants of the cabbage or mustard family (Cruciferae).

Injury.—Some years the caterpillars are not abundant enough to do much damage but about every second or third year on an average they become so numerous that they strip whole fields of cabbage and cauliflower of almost all their leaves except the midribs and larger veins. They also attack the heads and eat large cavities out of them. At the same time they deposit their dark green excrement in large quantities upon the heads, which, especially in the case of cauliflower, stains the head and makes it look most unsightly. The result is that a large part of the crop of both plants is rendered unmarketable. Usually late or moderately late sown plants suffer worse than the early sown ones, though at times the latter are also much injured.

Lift History.—The winter is passed in the chrysalid or pupal stage on the plants in the field or on boards or rails of fences or in any other sheltering quarters. The chrysalids are about three-quarters of an inch long, are roughly triangular in outline and vary in colour from green to grey or brown. From them the butterflies begin to emerge in May and in a short time commence laying eggs. These are yellowish, and are attached singly by the end to the leaves, chiefly on the under side. The eggs hatch on an average in five days. The larvae require two to three weeks to mature. They then change into pupae or chrysalids chiefly on the leaves or stems and in about ten days the butterflies emerge. The life cycle from egg to egg is therefore four to five weeks. There are at least three generations in the province and in the warmer portions probably a partial fourth. Larvae may be found in fields from about the first of June until the severe frosts come.

Control.—If taken in time the worms may be kept under good control by dusting the plants with arsenate of lead, paris green or derris. The first application should be made not later than when the heads are just beginning

to form on cabbage and just before the flowers are beginning to appear on cauliflower. Further applications, whenever new infestations show up, will be necessary. Arsenate of lead or paris green may be used on cabbage for these, but the last application should never be given later than 3 weeks before marketing for fear of poisoning consumers. There is also some danger to

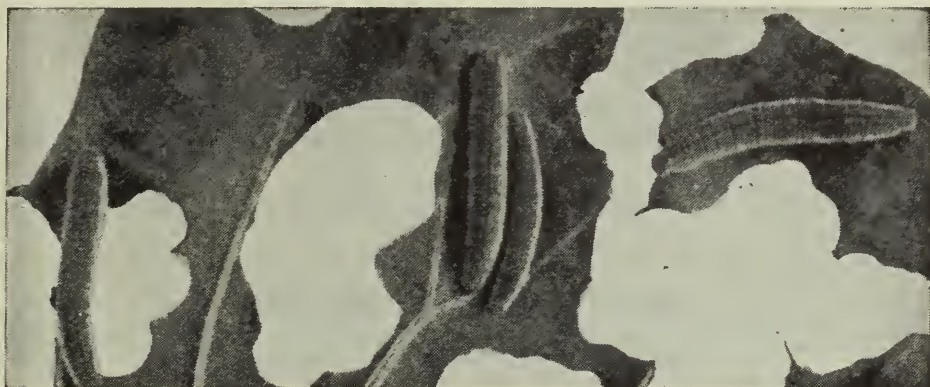


Fig. 26—Imported cabbage worms, natural size (after Britton).



Fig. 27—Work of imported cabbage worms on cabbage.

the consumers, if dusting is done with either of the above poisons, when there are deep holes in the heads into which the poison may fall or be washed. To lessen danger from the above poisons the outer set of leaves should always be removed before the heads are sold. In the case of cauliflower, brussels sprouts and broccoli, derris should be used for all but the first application to avoid danger of poisoning the consumer.

When using arsenate of lead as a dust, dilute it with talc, or gypsum, or fine, sifted road dust at the rate of 1 lb. of the poison to 3 lbs. of the diluent. Dilute paris green 1 lb. to 10 and derris 1 lb. to 7. Mix thoroughly in each case before applying. The best time to apply is when there is no wind and preferably when there is dew. The plants should be well covered, otherwise the kill will not be satisfactory.

Some persons may find it more convenient to spray than dust. In that case the strength of the arsenate of lead should be 1 oz. to 1 gal. of water, or 2 lbs. to 40 gals.; of the paris green $\frac{1}{2}$ oz. to 1 gal. of water, or 1 lb. to 40 gals.; of the derris 1 oz. to 1 gal. of water, or 2 lbs. to 40 gals. As cabbage and cauliflower leaves are very glossy a spreader such as soap or soap powder or skim milk powder should be added at the rate of 1 oz. of soap or $\frac{1}{4}$ oz. of milk powder to every gallon of water, or 2 lbs. of soap or $\frac{1}{2}$ lb. of the milk powder to every 40 gallons.

Note.—Derris varies in strength, hence a guarantee should be given by the dealer that it contains 4% rotenone, the chief killing substance.

Arsenate of lime (calcium arsenate) is used by some, but with us has not been satisfactory.

THE CABBAGE LOOPER

Autographa brassicae Riley.

The cabbage looper is a pale green caterpillar about one and one-quarter inches long, when mature, with white longitudinal stripes on the back and sides. The head end of the body is smaller than the rest. When the caterpillar walks it raises its body in a loop after the manner of cankerworms. This characteristic itself will easily distinguish it from other worms found on cabbage.

The adult is a dark brown moth with a conspicuous small silvery mark near the centre of each front wing. The moth is closely related to and resembles cutworm moths. It has a wing expanse of about one and a quarter inches.

Injury.—The cabbage looper feeds upon cabbage, cauliflower, turnips and other closely related plants, eating holes out of the leaves and boring into the heads. The injury is so similar to that of the imported cabbage worm that it would often be impossible to decide which was responsible, if the presence of the caterpillars themselves did not give the clue. Although present

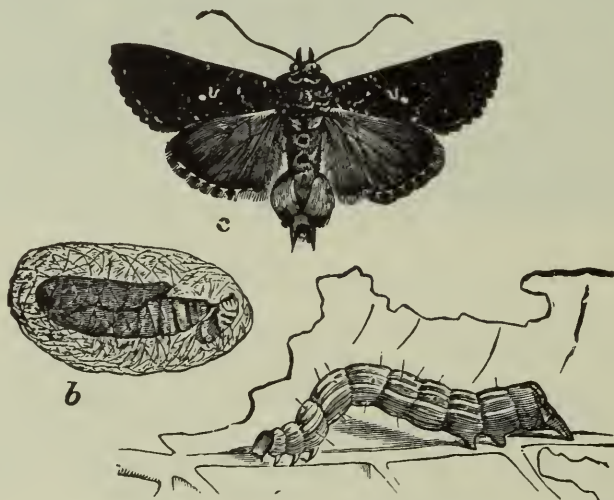


Fig. 28—Cabbage looper—(a) larva; (b) cocoon; (c) moth; all natural size.

to some extent every year, it is usually not so abundant as the imported cabbage worm and therefore not so destructive. There are, however, years when it is more abundant and more destructive.

Life History.—The life history has not been fully worked out for this province but is about as follows: The winter is passed in the pupal stage in a white silken cocoon usually on the plants themselves on which the larvae fed. In spring about the time cabbage plants are getting well established the moths emerge and lay their eggs on the leaves, generally on the under surface. The eggs are circular, whitish, and have ribs radiating out from the centre to the circumference. They hatch in four days. The larvae become full-grown, according to our rearing experiments, in an average of twelve days. The pupal stage requires the same length of time. Four days after emerging the moths begin laying their eggs; hence the life cycle from egg to egg requires approximately one month. There are apparently three generations a year, larvae of the last generation being present up to the end of October.

Control.—As the habits of the caterpillar are very like those of the imported cabbage worm the same means should be used to keep it under control. Control measures should, of course, always be applied before the insect has had a chance to do much damage and should be repeated as often as necessary.

CABBAGE APHID AND TURNIP APHID

There are two species of aphids which attack cabbage, turnip and other plants of the same family and which at times cause much damage. These are the so-called "cabbage aphid" (*Brevicoryne brassicae* Linn) and the "turnip aphid" (*Rhopalosiphum pseudobrassicae* Davis). These two can be distinguished readily from each other by the fact that the cabbage aphid is covered with a whitish powder and has a greyish-green appearance, whereas the turnip aphid is almost naked and is yellowish or light brownish-yellow in colour.

Injury.—Both are of course sucking insects and feed by piercing through the surface of the leaf with their sharp mouth-parts and extracting the juices. They live chiefly on the under surface of the leaves and during severe outbreaks may literally cover that side of the leaves and then swarm over onto the upper surface as well. The result is that in a short time the leaves become so drained of their juice that they turn a sickly-yellow colour and the plants either die or are much dwarfed. If the attack occurs late in the season turnips often begin to decay and the odour may be detected half a mile away. Sometimes, however, disease, parasites and other natural enemies step in and save the crop just when it seems doomed. This is especially so in the case of the turnip aphid. Fortunately most years neither species is abundant enough to do much harm. Of the two, the cabbage aphid is the more common, but severe outbreaks even of it usually occur only about one year in five.

Control.—Both species of aphids are difficult to control, largely because it is hard to hit with a spray or dust a high percentage of them on the under-side of the leaves, where most of them feed. In a severe outbreak of the turnip aphid in Ontario in 1934 the writer and an assistant tested ten of the most promising insecticides. To their surprise the one most highly recommended, namely, nicotine dust, failed to give control, even when used at 4% strength and heavily applied. It stupefied the insects, but most of them recovered and resumed feeding. The most satisfactory insecticide tested was linseed oil soap at the rate of 1 lb. to 10 gals. of water. This killed practically 100% of all that were hit. Other soaps were also good but not quite the equal of this. Soap was also the cheapest material tested. Derris was fairly promising but much more costly. When applying the soap spray the operator

should use a short spray rod about 3½ ft. long, curved at the top, and equipped with one or two disc nozzles, according to the pressure used. This makes it possible to hold the nozzle very low, usually touching the soil, and thus force the spray up beneath the leaves. The work has to be done slowly and with great care, but it can be done, provided the grower has a good or fair spray outfit.

For the cabbage aphid most entomologists recommend a nicotine dust. This should be about 3% in strength. It should be applied only in warm or moderately warm calm weather, and must of course hit the aphids to be effective.

The linseed oil soap wash was not tested on this variety by the writer, but there is little doubt that it would be satisfactory.

Any control measures adopted should be applied promptly once the aphids are seen to be numerous enough to indicate a coming outbreak. One good treatment will usually suffice.

As many aphid eggs winter over on the leaves and stalks of cabbage, turnips or other closely related plants, it should be of some value to plow down all crop remnants in the fall and thereby destroy many eggs.

DIAMOND-BACK MOTH

Plutella maculipennis Curtis.

The diamond-back moth is the adult of a small light-green worm, which attacks cabbage, cauliflower, brussels sprouts, turnips and many other closely related plants.

The larvae can be distinguished readily from the imported cabbage worm and the cabbage looper by its size: when full-grown it is a little less than half an inch long; whereas the other two larvae are each an inch or more in length. Its head is greenish-brown with many darker brown spots on it; the heads of the other two species are either pale or dark green with no noticeable markings. Under a hand lens the imported cabbage worm, even in its immature stages, is seen to be densely covered with very fine hairs with little dark specks among them. The diamond-back larva is hairless except for a few short spines. The cabbage looper has white stripes down the back and sides, the diamond-back has none.

The adult is a small greyish-brown moth with a slender, dark brown body and a wing expanse of about two-thirds of an inch.

Injury.—Though this insect is not nearly so important as either the imported cabbage worm or the cabbage looper, yet it is present to some extent every year and occasionally becomes so abundant as to cause much damage. The larvae feed chiefly on the under side of the leaves and eat small areas almost through them. The epidermis immediately above these areas dies and a hole soon forms. If the larvae are very numerous they do so much feeding that the plants at a distance look almost bleached. In such cases the crop is of course largely ruined. When brussels sprouts are attacked the insect often bores into the nubs and makes them unsaleable. The worst attacks recorded in Canada have taken place in June, July and August.

Life History.—The life history of this insect has not been carefully worked out in this province. There seems no doubt, however, that the winter

is passed in the moth stage under leaves or other good hiding places. The pupae seem unable to withstand even a moderate degree of frost and so must all perish with the advent of winter. In the spring, soon after cabbage and other allied plants are set out, the moths appear and lay their tiny yellowish to whitish eggs on the under side of the leaves. These hatch in a few days



Fig. 29.—Diamond-back moth—(a) adult; (b) larva; (c) pupa; (d) cocoon on leaf. (a, b, c adapted from Marsh, U.S.D.A.; d is original). All about natural size.



Fig. 30.—Work of diamond-back moth on turnip leaf. (After Marsh, U.S.D.A.).

and larvae may become numerous in June. When full-grown the larvae construct a thin lace-like, silken cocoon on the leaves and pupate in this. The whole life cycle from egg to adult may be passed in about 25 days, hence, as all stages are found up to the end of the season, we are safe in inferring that there are at least three generations and possibly four.

Control.—The same control measures should be used as given for the imported cabbage worm.

TURNIP OR STRIPED FLEA BEETLE

Phyllotreta vittata Fab.

Many a farmer in this province has from time to time had his turnips destroyed by a little black beetle about one-twelfth of an inch long with a wavy inconspicuous yellow stripe down each wing cover. The injury is nearly always done during the first week or two after the plants have come through the ground. It is brought about by the beetles eating so many holes in the little leaves that these wither up and the plants die. Farmers usually speak of the insect as the "turnip fly." It is, however, not a fly but a beetle and is called by entomologists the turnip flea beetle or the striped flea beetle.

The larva is a yellowish-white worm with a brown head. It is slender and one-third of an inch in length when mature.

Food Plants.—Although the injury to turnips is greatest yet radishes, cabbage and cauliflower are also sometimes severely attacked, the latter two often in seedbeds. In addition the insect attacks wild mustard and several other plants of the cabbage family, whether wild or cultivated.



Fig. 31.—Work of turnip or striped flea beetle on radish leaves, natural size.

Life History.—The life history does not seem to have been carefully studied. The winter is passed in the beetle stage under leaves or rubbish or anything else that affords good shelter, usually near where the insects have been feeding. In May the beetles come forth from winter quarters and begin feeding on various food plants. When turnips, radishes or cabbage appear above ground they often migrate from nearby places to them and eat holes in the leaves. Eggs are laid around the base of the food plants, sometimes in cavities eaten in the main root. The larvae from these eggs feed upon the roots but evidently do little harm. Pupation takes place in the ground. There is little doubt that there is only one generation a year. The beetles of the new generation appear in summer and feed upon the leaves of their regular food plants until the appearance of frost, when they go into winter quarters. Almost no damage is done by this feeding as the leaves are then large and can withstand a lot of feeding.

Control.—The destruction of weeds, especially those of the cabbage or mustard family, such as all kinds of mustard, peppergrass and shepherd's purse, will lessen the number of beetles in the vicinity and so lead to less injury of cultivated plants the following year. Feeding off or ploughing under all remnants of cabbage, turnips and closely allied plants in the fall of the year would also help in the same way. Burning of grass and rubbish in early spring will destroy many of the beetles which wintered in these.

Seed beds of cabbage and cauliflower may be protected by cheesecloth screens, which must of course be put on before the beetles appear in spring and kept on until the plants are about ready to be transplanted.

Turnips sown after the 21st of June are seldom severely attacked, as the beetles will largely have disappeared by the time such plants are through the

soil; hence if the early sown turnips are killed it is usually safe to work the soil up again and re-sow at once.

When the young plants soon after coming through the ground are being attacked severely, they may be protected by one of the following methods.

1. By dusting with a poisoned Bordeaux dust made by thoroughly mixing together monohydrated copper sulphate, hydrated lime (fresh), and arsenate of lead in the proportions of 1 part (by weight) of the first, 4 parts of the second, and 1 part of the third. Sometimes a poisoned Bordeaux spray is used instead of the dust and is composed of 3 lbs. arsenate of lead in a 4.4.40 Bordeaux mixture.

2. By dusting with powdered derris (guaranteed to contain 4% rotenone) diluted with 6 times its own weight of talc or cheap flour or gypsum (not of hydrated lime).

3. By dusting with barium fluosilicate or cryolite diluted with four times its own weight of talc, or cheap flour, or fine clay, or gypsum (not of hydrated lime).

Dusts should be applied only in calm weather and preferably when there is a little dew. The outlet of the duster should be held close to the plants to save waste and to secure a good covering. The nozzle of the sprayer should also be held close to the plants.

Experiments in several places indicate that of the above mixtures the derris is the most effective. Several spray companies are now selling it and guaranteeing the strength. Some of these companies sell also a derris or cubor dust (practically the same as derris), diluted in the factory to the desired strength. This will be a little more expensive, but more convenient and will be thoroughly mixed.

ZEBRA CATERPILLAR

Mamestra picta Harris



Fig. 32.—Zebra caterpillar and adult.

The zebra caterpillar is a pretty larva with alternate black and yellow longitudinal stripes on its back. It, of course, receives its name from these conspicuous markings. The caterpillar when full-grown is nearly two inches long.

The adult is a stout, dark, reddish-brown moth with a wing expanse of one and one-quarter inches.

The larvae usually are not abundant enough to do much harm but every once in a while they occur in great numbers in autumn, especially on turnips and cabbage, and almost entirely defoliate these plants. They sometimes are fairly numerous also on celery and a few other plants.

Life History.—The winter is passed in the pupal stage in the ground. The moths emerge in May and lay eggs in clusters on the leaves. From these come the first brood of caterpillars. These work during June and early July. When full-grown they pupate in the ground, and from the pupae moths begin emerging late in summer and produce the fall brood of larvae which feed in September and early October and are almost always more injurious than the spring brood.

Control.—The caterpillars can be destroyed with considerable ease by dusting the plants heavily with paris green mixed with about ten times its own bulk of hydrated or air-slaked lime or gypsum. Arsenate of lead or arsenate of lime with about four times their own bulk of lime or gypsum may be substituted for the paris green. It must always be borne in mind, however, that an arsenical should not be used at any time of the year on foliage which is likely to be fed to cattle or other livestock or which human beings may use.

INSECTS ATTACKING CORN

EUROPEAN CORN BORER

Pyrausta nubilalis Hubn.



Fig. 33.—European corn borer adults, female on left, male on right, natural size. (J. Marshall.)

The European corn borer is a very destructive insect, one of the most destructive ever introduced into Canada. Given favourable conditions for several successive years it is capable of increasing so rapidly as to threaten the very existence of the corn industry.

The borer itself is a whitish or brownish-white caterpillar, sometimes with a pinkish or purplish tint. When full-grown it is about an inch long. The head is brown and the body has many small brown dots over the back.

The female adult is a creamy-yellow moth with brownish markings on the wings. The male is a little smaller than the female and darker in colour, being pale brown with creamy-yellow markings. (See figure 33.)

Food Plants.—In Ontario corn is by far the most important food and

breeding plant, about ninety-nine per cent. of all the eggs being laid on it. A small number of eggs is occasionally deposited on dahlias, gladioli, zinnias, hemp and a few other plants, but at no time in this province have any of these had sufficient borers to be of any significance. It is true, however, that corn

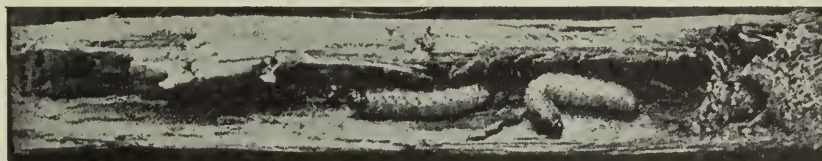


Fig. 34.—European corn borer in burrows in pieces of cornstalks, a little reduced; the larvae should be about one inch long. (G. Spencer.)

borers are often found in weeds, but only if the weeds are growing among the corn or alongside it. In such cases the eggs were not laid on the weeds but on the corn and the borers when moving about, as some of them do, entered the weeds and remained in them. When borers are found in weeds or other stout plants at some distance from corn they will not be corn borers but different insects. We have about a dozen kinds of borers which live in stout weeds. Some of these look much like corn borers, but a careful comparison will show they are not.

Injury.—In corn the borers work into and make burrows in any part of the plant large enough to conceal them from the tassel down to the root and including the ear. A severely infested cornfield is a saddening sight: almost



Fig. 35.—Field of corn badly broken down by borers. (Photo by H. G. Crawford, August 19th.)

every tassel is broken off; every leaf killed and either fallen off or hanging close to the stalk; the ears are broken down, many of them are rotten, the remainder are stunted and most of them are riddled by borers; the stalks are punctured by borer holes on the outside and darkened with filthy burrows and borer castings inside; thus the whole field is reduced to a tangled mass of worthless, rotting plants.

Sweet corn is usually worse injured than field corn, largely because a higher percentage of the borers are able to get established and survive in it, and because, if even thirty per cent. of the ears are attacked, the corn is rendered unsaleable for table use, and rejected by the canners.

Life History.—The winter is passed as full-grown borers in any part of the corn plant, including the stubble, large enough to hide them, and also in weeds among or close to the corn. In June the borers change to pupae in these winter quarters and about the first of July the moths begin to come out and continue to do so throughout the month. Eggs are laid in a few days after the moths appear. They are white, circular, and flattened, and are placed in clusters averaging about 16 eggs each on the underside of the leaves. The eggs hatch in 4 or 5 days and the little borers soon work their way down to the crown or stalk and bore into it or into the tassels or ears. As they get larger some of them migrate from one part of the plant to another or from one plant to another or to a weed. They are all full-grown early in September, and then cease feeding but remain in their burrows all the rest of the fall and winter. There is only one brood a year in this province.

Control.—By far the simplest, most practical, and most economical method is to kill the borers either in fall or spring while they are still in the corn plants or their remnants, including the stubble, or in the weeds which grew up in the cornfield. The first step in doing this is to cut the corn just as low as possible. Many use a hoe and cut level with the ground. In any case it should not be cut higher than 5 inches. The next step is to ensile the stalks or feed them whole or shredded or cut with a cutting box. Any borers ensiled or eaten by cattle perish. The third step is to plow the stubble under very carefully with a wide-bottom plow. It often pays to crush the stubble first by running a heavy planker or leveller or roller over it both ways, or by discing it twice deeply. This makes good plowing under easy. The fourth step is when working the land to use a disc instead of a toothed implement so that as few stubble as possible will be dragged up and have to be picked up and burned. The last step is to gather and burn or plow under completely all stalks, pieces of stalks, and stubble left above ground in the field, feeding places, barnyard or elsewhere. All this should be done before May 20. If left much later moths would emerge and lay eggs, or grain or grass grow up and conceal the stalks, etc.

As there are many little plots of sweet corn in villages and towns, and as these are often heavily infested, they, too, must be cleaned up. The best method usually is to leave them until spring, when they will pull easily, and then pull them along with stout weeds while dry, throw into heaps and burn at once. This will destroy almost every borer present.

Dusting sweet corn with a poison is too costly and it is difficult even with the best dust to get a high percentage of control.

If the borers were abundant the previous year it will be wise not to plant all the corn early but to put in about one-third early, one-third a week later, and the remainder nearly a week after this. Then if the early corn is severely injured the later plots will largely escape, because the borer regularly attacks the earliest corn more heavily than the later.

Cooperation on the part of all growers is necessary in combating the borer. The Plant Diseases Act gives any council the power to appoint inspectors to enforce the regulations for cleaning up of cornfields and other corn remnants.

It will be interesting to most persons to learn that years in which June and July are hot and dry are usually very unfavourable to the borer and kill many of the pupae, or many of the tiny larvae, before they can enter the plants. On the contrary, years in which there is plenty of moisture and good growing weather in June and July are very favourable to the borers and make it very difficult to prevent an increase.

CORN EAR WORM

Chloridea obsoleta Fabr.



Fig. 36.—Corn ear worm and its work, natural size.

The corn ear worm receives its name from its habits of working in the ears of corn. It occurs almost exclusively in late summer and autumn and, while seldom of much importance, occasionally becomes very abundant and then does a great deal of damage to the ears by feeding on the kernels. In 1921, it occurred in such countless numbers all over the province that canning factories in some cases had to cease canning late corn.

Many persons confuse this caterpillar with the European corn borer but they may be distinguished easily by the fact that the European corn borer is only 1 inch in length when full-grown and is whitish or brownish white with many small brown dots on its body; whereas the corn ear worm is $1\frac{1}{2}$ inches long, varies greatly in colour, some being blackish, others brown, others green and others pinkish. Moreover, regardless of the colour, it usually has a broad longitudinal stripe along the side and lacks the small brown spots over the body characteristic of the corn borer. Another difference is that the corn ear worm limits its work almost entirely to the ear, especially the upper half of it, whereas the European corn borer bores into any part of the plant large enough to conceal it and is more common in the stalks than in the ears.

The adults of the ear worm are stout moths with a wing expanse of about $1\frac{1}{2}$ inches and the same general appearance as cutworm moths, to which indeed they are closely related. The colour varies greatly, some being dull olive green, others yellowish and others light-brown. The wings are usually bordered with darker bands.

Life History.—This will not be given here in detail further than to say that apparently the insect does not winter in this province, at least to any appreciable extent, and that the caterpillars we find in the corn in autumn all or almost all come from moths which have migrated here from the southern

part of the United States, where this insect is a great pest, not only of corn, but also of cotton. In this province almost all of the insects seem to be destroyed by low temperatures while in the pupal or wintering stage.

Control.—There is no satisfactory control method adapted to our conditions and of course control measures are only rarely required in this province. However, the earlier the corn is planted the less likely it is to be attacked.

INSECTS ATTACKING CUCUMBERS, CITRONS, MELONS, PUMPKINS, SQUASH AND VEGETABLE MARROW

STRIPED CUCUMBER BEETLE

Diabrotica vittata Fab.

By far the most common and destructive insect attacking cucumbers, squash and closely allied plants is the striped cucumber beetle. This beetle is about $\frac{1}{4}$ inch long with black head, yellow thorax and yellow wing covers with three distinct longitudinal black stripes on them.

The larvae, which are seldom seen, because they live beneath the surface of the soil, are slender, white worms with brown heads. The average length when full grown is about $\frac{1}{3}$ inch.

Food Plants.—The favourite food plants of the beetles are cucumber, squash, pumpkin, vegetable marrow, melon, canteloupe, and citron. In the early part of the season they feed to a considerable extent also upon wild cucumbers, beans, burdocks, stinging nettles, pigweed, peas, radishes and curled docks. Later they may be found on the silk of corn and the flowers of asters, sunflowers and several other plants.

The larvae feed on the roots of cucumber and other cucurbits.

Injury.—The main injury takes place from the time cucumbers, melons or other favourite food plants mentioned above have just come through the surface until they begin to send out runners. During this period and especially just after the plants have come through the soil the beetles attack the leaves and often kill the young plants. Sometimes 50% or upwards of the plants in a large area are thus destroyed in less than a week. After the plants are far enough advanced to have begun sending out runners they grow so rapidly that the beetles can no longer do much harm. Moreover, once the flowers appear the insects prefer them to the leaves. Fortunately they do but little harm to the flowers.



Fig. 37.—Striped cucumber beetle—adults, larvae and pupae, all natural size. (J. Marshall.)

Another form of injury and a very important one some years is caused by the beetles transmitting a very destructive bacterial disease, known as "cucumber wilt," from diseased to healthy plants. A plant attacked by this

disease suddenly wilts and dies. So far as known the striped cucumber beetle and its close relative, the 12-spotted cucumber beetle, are the sole agents in the spread of this disease.

The larvae, even though they feed on the small roots and bore into the larger ones, causing deformities in them, seldom do much damage if the plants are thrifty; but if the soil is poor and the plants not thrifty they may cause considerable damage.



Fig. 38.—Cucumber leaf with beetles feeding upon it, natural size.

Life History.—From our own studies and those of other investigators there seems no doubt that the only stage in which the insect winters is the adult. In this stage they have been found hibernating in dense grass, under leaves in woods and beneath remnants of the crop. In the spring about the time of the full bloom of apples or a little later, the beetles come out and at once attack young cucumbers, squash, melons or similar plants which have been transplanted or have appeared above ground from the seed. If these are not present, they feed in the meantime on wild cucumbers or on some of the other plants mentioned above but quickly desert them for cucumbers, squash and other cucurbits as soon as these appear. In about two weeks egg-laying begins and continues into August. The eggs are yellow and are laid singly or in clusters in the ground at or near the stem of the favourite food plants. Eggs hatch on an average in about ten days. The larvae feed on the roots as already mentioned. The larval period usually lasts about a month. Pupation then takes place in the soil near where the larvae fed. The pupae are enclosed in little earthen cells and if these are broken they usually perish. The pupal stage requires an average of about two weeks. About the first week in August the new beetles begin to emerge and continue doing so for several weeks. There is only one generation a year. The new generation of beetles feeds chiefly on the flowers of cucurbits and other plants and does but little damage. The beetles go into winter quarters soon after frosts have come in autumn.

Control.—It is always helpful if the soil is well prepared and fertilized before planting, for the plants then grow more rapidly and are thus able to withstand better the attacks of the beetles.

It is also a good plan in localities where the beetles are very numerous to sow the seed thicker than usual. Then, if too many plants are left after the height of the attack is over, these can be thinned out.

For ten years or more the most common insecticide used against the beetles has been a mixture of calcium arsenate and gypsum in the proportion of 1 part by weight of the former to 19 parts of the latter. (Some growers use 1 part to 10 parts.)

Recently several experimenters have reported that derris powder (guaranteed to contain 4% of rotenone), diluted with 6 times its own weight of talc, cheap flour, or clay, has given much better results than the calcium arsenate and gypsum and kills a much higher percentage of the beetles. Some other experimenters, however, report unfavourably of derris. It is possible that the explanation of the failure in these cases may be attributed to the derris having been exposed to sunlight at some time and having thereby lost its effectiveness. It must be kept in the dark or it soon loses its strength.

Another mixture highly recommended by one experimenter, is a spray made of 2 lbs. calcium arsenate in a Bordeaux mixture composed of 2 lbs. bluestone, 2 lbs. hydrated lime, and 40 gals. of water. This, however, sometimes causes some injury to the plants. It is probable that the danger of injury could be eliminated by substituting for the bluestone 2 lbs. of coposil or copper hydrate or some of the other copper substitutes for Bordeaux mixture which have recently come on the market. Hydrated lime alone tends to dwarf cucumbers and closely related plants. For the preparation of Bordeaux see page 7.

Whatever material is used the grower should inspect the young plants every second or third day after they appear above the ground for beetles, and as soon as they are numerous enough to do any appreciable damage, should apply some one of the above three mixtures. Whatever mixture is used, whether a dust or a spray, should be applied to both surfaces with special attention to the lower surface because most of the beetles feed there. The application should be repeated whenever the beetles have again become numerous enough to do damage. Most years four applications will be sufficient, but more will be required in wet seasons.

If a spray is used the nozzle should be held close to the young plants and if a dust is used the outlet should also be held close to them. This will lessen greatly the amount of material necessary to cover each plant properly. Dusting should usually be done on a calm day, or in the calmer part of the day.

SQUASH BUG

Anasa tristis DeGeer.

The squash bug is a large, stout, dark-brown insect about $\frac{2}{3}$ inch long and nearly $\frac{1}{4}$ inch wide. It attacks all our common cultivated plants of the squash family as squash, pumpkin, cucumber, melon, canteloupe and vegetable marrow. Of these, squash and pumpkin are favourites. Though the insect may be found at times over most of the province, it is somewhat rare except in the southern part along the lake counties from about Toronto west to Windsor.

Injury.—Both adults and nymphs feed on the leaves of squash and the other plants mentioned by piercing through the surface with their sharp mouth-parts and sucking up the juice. In the course of this operation it is believed they inject a poison into the tissues which increases the injury. The first evidence of attack is usually the formation of pale-green areas here and there on the leaves. These areas later turn brown, wither and die. If the insects are very abundant many vines may have all their foliage turn brown

and die, much as if a fire had run over them ; but it is seldom that the injury is nearly so severe as this, the bugs usually being only numerous enough to destroy a few plants or a number of leaves here and there throughout the plot. Probably their habit of feeding together in groups while they are young helps to prevent more general injury. Occasionally some damage is done to the fruits by the insects feeding on these and making small cavities on the surface,



Fig. 39.—Squash bug, showing different stages of nymphs, an adult and egg mass on leaf, all natural size. (J. Marshall.)

but usually these are insignificant ; for fruits are seldom attacked until after frosts have killed the vines. The insect, however, is capable of doing great damage and the fact that it seldom does much seems to be due to its being well kept under control by natural factors and by the practice of cleaning up fields in the fall of the year. Usually gardens in towns and villages suffer more than open fields, probably because the surroundings in such cases afford more favourable hiding places for winter-quarters for the bugs than they could secure in the open.

Life History.—The winter is passed in the adult stage in any good shelter, such as afforded by barns, sheds, heaps of stones, piles of boards or of fire-wood, brush or even garden refuse. The adults usually do not emerge from these winter quarters until June, though we have occasionally seen them on plants in the latter part of May. Egg-laying begins in June, is most common the latter half of July, and ends about the first week in August. The eggs are placed on the under side of the leaves, but a few may be found also on the upper surface. The clusters can easily be found, as the eggs are large and conspicuous. When laid they are creamy-yellow, but soon turn light-brown and before hatching a dark chestnut-brown. They hatch in 7 to 17 days. The nymphs for a few hours after hatching are green, with red heads, antennae and legs. The red soon turns black and the green of the body becomes in all the later nymphal stages grey or greyish brown. For some time after hatching all the nymphs from a single egg-cluster feed together, usually on the under side of the leaves. As they grow large they separate. The nymphs mature slowly, usually requiring a month or more to reach the adult stage. Often the later ones are still in the nymphal stage when frost kills the vines. In such cases both nymphs and adults may be found feeding together on the fruits. All nymphs either become adults or perish before winter.

Control.—1. From what has been said above as to the habits of the adults, it will be evident that cleaning up the plantation and burning all remnants of the crop before winter will destroy many of the bugs. Moreover, gathering and burning in fall of all rubbish and brush in the vicinity will destroy many of the wintering places and lessen the number of adults that will be present the next year.

2. As the bugs are almost always most numerous and destructive in towns and villages and in small gardens on the farm where the total number of squash or other cucurbits is small, the simplest and best method of control in such cases is to collect the adults every two or three days from the time they begin to appear in June to about the middle of July. Collecting may be made easier by placing pieces of boards or shingles or other protecting materials on the ground throughout the plot. Most of the adults will hide under these at night and can be picked up in the morning and killed by throwing them into a pail or can containing an inch of water and a cupful of kerosene. Examination should also be made at least once a week for the clusters of the large brown eggs on the underside of the leaves, and these crushed by hand or torn off and thrown into the kerosene and water.

3. Many insecticides have been tested against squash bugs but all except a very few have been valueless. Those which are effective are usually difficult to obtain or too costly. Nicotine sulphate or nicotine dusts will stupefy the insects but most of them soon recover. The same is true of most pyrethrum dusts and sprays, though it is claimed that some of the new stable pyrethrum mixtures are fairly effective, if used about three times as strong as recommended for most other insects. If any spray or dust is used the best time to apply it would appear to be about sunset, because many of the bugs have then left the leaves and collected in little clusters on the ground beneath the plants. For this reason after spraying the under side of each plant showing any symptom of attack, the ground beneath should also be sprayed well to kill any bugs already there and any that the spray may cause to fall.

MELON APHID

Aphis gossypii Glover.

The melon aphid is so rarely troublesome in Ontario that only a brief account of it is given here.

The aphid varies in colour from nearly white to dark-green. Its favourite food plants are melons and cucumbers, but it also feeds to some extent on many other plants, including weeds. It is fairly common in greenhouses. In addition it is one of the chief agents in disseminating the disease known as cucumber mosaic.

In the field melons are not usually attacked by the aphids until the vines have just begun to run. When, as occasionally happens in the south-western part of the province, these aphids become abundant, the leaves are curled, the plants become sickly, dwarfed, and some of them die, and the whole crop is greatly lessened.

The aphids winter over in the egg stage on a garden plant, which often runs wild, known as live-for-ever or common orpine (*Sedum purpureum*). They also winter in greenhouses, where breeding continues all through the winter.

Control.—The same method of control should be used as for other aphids attacking vegetables, namely, dusting the plants with a 3% nicotine dust.

This must be applied thoroughly to the under side of the leaves, where the insects work, on a warm, calm day. Dusting should be done promptly once the aphids are seen to be likely to injure the plants. In greenhouses the usual fumigation with tobacco or with hydrocyanic acid gas will control the insect. Repeat the dusting or fumigation when necessary.

INSECTS ATTACKING ONIONS

ONION MAGGOT

Hylemyia antiqua Meigen.

The onion maggot is the most important pest attacking onions in Ontario. It is a small white maggot resembling closely the cabbage maggot and having similar feeding habits except that instead of attacking cabbage and allied plants it attacks onions.

The female adult is an ashy-grey or olive-grey coloured two-winged fly so like the female fly of the cabbage maggot that the grower cannot distinguish between them. The males are darker and a little smaller than the females, and they, too, are almost identical with the males of the cabbage maggot.



Fig. 40.—(a) Onion maggot adult, about natural size; (b) and (c) young onions with lower part of stem destroyed by the maggot; (d) young onion with both root and bulb attacked; (e) uninjured onion from seed sown at same time as b, c and d.

Injury.—The maggots bore into the leaves, stems and bulbs of the young onions and by tearing the tissues and sucking the juices kill the plants. When one plant is killed the maggot often migrates to another. In this way several plants may be destroyed while still small by the same maggot or maggots. When the plants get larger the maggots limit themselves chiefly to the bulbs

and by working in them make them unfit for sale. Often rot enters infested bulbs and not only increases the damage but also causes a sickening odour. The amount of loss from the maggots varies greatly from year to year; some years little damage is done, others a great deal, some fields having 50% or more of the crop destroyed. All varieties of onions except Egyptian are attacked. The thick hard skin on the Egyptian onion seems to protect it.



Fig. 41.—Work of onion maggot. (After Gibson and Treherne.)

Life History.—The winter is passed as pupae (puparia) in the soil near the plants fed upon the previous year. The pupae are reddish-brown and resemble large grains of wheat. In May, about the time bloom is beginning on apple trees, the flies begin to emerge and continue to do so for several weeks. In 4 to about 10 days after emerging the females begin laying eggs. These are white and of the same size and shape as those of the cabbage maggot (See fig. 24). In the early part of the season nearly all the eggs are laid in the soil near the onions themselves; later many are laid on the bulbs and some in the axils of the leaves. The eggs hatch in about 5 days on an average. The maggots feed as described, and usually become full-grown in about 15 days. They then pupate in the soil or at times in the infested bulbs. The pupal stage also requires about 15 days. Then the adult appears. Thus the length of the life cycle is approximately six weeks. There are usually three broods a year of the insect in this province, the first brood of larvae being present in May and June, the second, roughly speaking, in July and August,

and the third in September and October. The second and third broods are not full broods but only partial. Larvae are present in the bulbs right up to the time of severe frosts, in fact, some of them are carried into storage in the bulbs and mature there.

Though there are three broods each year it is usually only the first that does serious damage.

Control.—The method of control most used up to the present is by spraying with a 2% or a 2½% lubricating oil emulsion. This is usually combined with a 4-6-40 Bordeaux mixture. The Bordeaux helps to prevent injury to the plants and also acts as a fungicide. The grade of oil used varies a good deal but usually is moderately heavy, cheap lubricating oil with a gravity of 24 to 27 A.P.I., a viscosity of 100 to 200 seconds, and an unsulphonatable residue of 60 to 90%. This oil costs about 30c a gallon and therefore the cost of the oil in every 100 gals. of the diluted emulsion with a 2% strength is about 60c to 75c. Oil of the above nature may be secured from any of the large oil companies.

In making the stock emulsion, that is the emulsion before it is diluted to the required strength, we use oil, water, bluestone, and fresh hydrated lime in the following proportions:

Oil	1 gal.
Water	1 gal.
Bluestone	2 ounces
Hydrated lime	2 ounces

These proportions must always be kept, but any multiple of the amount may be used to make up larger or smaller quantities as needed. For instance, suppose your tank holds 150 gals. and you want to make a full tankful, and that the strength of oil required is 2%, that is 2 gals. in 100; then for a 150 gal. tank you will need $\frac{150}{100} \times 2 = 3$ gals. of oil. So to keep the right proportions you must now use, oil 3 gals., water 3 gals., bluestone 6 ounces, and hydrated lime 6 ounces, that is three times each of the amounts given in the formula above. Having got these right the next step is to dissolve the bluestone in half the water (1½ gals.); mix the hydrated lime in the other half of the water (1½ gals.); then at once pour the latter into the former and stir vigorously for a minute. Now pour this mixture into the spray tank and add to it the 3 gals. of oil. Then start the engine and pump the liquid through the nozzles back upon itself. Hold the nozzles 6 to 10 inches from the mixture in the tank and use good pressure. After 5 minutes the oil should all be thoroughly emulsified in the water. We must now fill the tank with Bordeaux 4-6-40. To do this place the requisite amount of finely powdered bluestone—15 lbs. for the 150 gal. tank in question—on a burlap screen over the inlet to the tank, and pour water through this until it is all dissolved and the tank is full. Then with the engine still running to keep the mixture agitated, add slowly the hydrated lime, 22½ lbs., and continue the agitation for about 4 minutes. At the end of this time the mixture is all ready for spraying on the plants.

Note.—Bluestone is sold in two forms: a fine powder often called “snow,” and large crystals. In the above directions we have assumed that the powder form is being used, because it can be dissolved fairly quickly by stirring in water, or by having the water run through it, whereas the large crystals cannot. If the latter are used the best method is to put 40 lbs. of them in a sack and hang this in a 40 gal. wooden barrel full of water so that the sack will not sink lower than 4 or 5 inches into the water. If this is done in the evening all the bluestone will be dissolved by the next morning. If the barrel

is then stirred each gallon of the liquid will contain 1 lb. of bluestone, or each pint 2 ounces. For example, if the formula calls for 6 ozs. of bluestone to be dissolved in $1\frac{1}{2}$ gals. of water—take 3 pints of the dissolved bluestone and dilute to $1\frac{1}{2}$ gals., then proceed to make the emulsion as given above. Similarly when making the 4-6-40 Bordeaux mixture, if 15 lbs. of bluestone are required, as in the case of the 150 gallon tank, take 15 gals. of the dissolved bluestone and pour it into the tank, while the tank is being filled with water, then add the lime.

In some cases it may be more convenient to make up enough stock emulsion for a whole day's spraying and store this in one or more wooden barrels instead of making up the emulsion for each tankful by itself. Having on hand this stock emulsion, all that it is necessary to do is to estimate how many gallons are necessary to put into the tank so that when the tank is full there will be 2% or $2\frac{1}{2}\%$ of oil. (The stock emulsion of course is half oil.) Having put this amount in, proceed to fill the tank with water and make up the Bordeaux as described above. The engine should be running all the time while the water is going in and the mixing is being done.

Caution.—Do not forget to stir the stock emulsion in the barrel before taking any out because otherwise it would not be uniform in strength. Remember, too, that bluestone corrodes most metals and so should be used in wooden vessels.

Time to Apply the Spray and Number of Applications.—The first application should be made just as soon as the flies begin to lay their eggs in spring. This will usually be when the earliest apple trees are just coming into bloom. If the onions are not up until later than this, spray as soon as the little plants are just high enough to show the rows clearly, that is when they are not quite an inch high. As the oil sometimes burns or stunts the plants a little in very hot weather, it is better not to spray in the hottest part of such days, nor is it wise to spray on a cold day.

The spray should be repeated after an interval of a week, not longer, and again at the end of another week. Usually three sprays are all we give, but some give four.

Method of Application.—Since the oil emulsion controls by repelling the flies from laying their eggs, the spray must thoroughly wet all the soil in and among the plants and for a few inches on both sides of them. To do this, hold the nozzle about 6 inches above the ground so as to cover a strip extending from 2 to 4 inches beyond the outer part. A moderately coarse spray is desirable, therefore the opening in the nozzle should be fairly large. A large disc type of nozzle is the best kind. The pressure should not be more than about 200 lbs., for higher pressure may injure the tiny plants. From 125 to 150 gals. of spray per acre is not too much.

Any type of spray equipment can be used providing the above method of application is closely followed. For small plantings, the knapsack type of sprayer (See Fig. 5) is very suitable as one man can do the work. Two men can cover the field fairly quickly using the wheelbarrow type (Fig. 6). Small garden-type tractors fitted with sprayers, and set so that the wheels follow the spaces between the rows, can be used to advantage. If a grower has a large orchard spray machine, he may use it. In this case it is wise to attach a swinging arm or boom about 15 ft. long on each side to the top of the tank near the rear. To each of these a line of hose is attached and allowed to extend about 10 ft. beyond the end and to this is joined a short spray rod about

4 ft. long with an angle disc nozzle at the end. Then by swinging the boom around gradually, two operators can do a wide area each round.

A comparatively new and very simple method of controlling the onion maggot by means of calomel has recently come into use in the United States. So far in the sections of Ontario where we have tested it, it has given satisfactory control and has the following advantages over the oil emulsion: careful timing is not necessary as the calomel is applied to the seed, the labor involved is slight, and there is no danger of stunting the plants. We hope soon to improve and standardize the details of the method for Ontario conditions, and in the meantime we advise growers who suffer losses from the onion maggot to test it out on part of their field, in comparison with the oil emulsion method. Further testing is necessary before we can recommend it unreservedly.

Briefly, the method as used for field onions sown at the usual rate of from 4 to 6 lbs. per acre is as follows: For each pound of seed use from 1 to 1½ lbs. of finely powdered calomel. First take enough seed to fill the seeder once, place it in a cheesecloth bag and thoroughly soak in water until all the seed is wet. Then drain off all the surplus water by whirling the bag at arm's length a few times so as to leave the seed just moist. Pour the damp seed slowly into an open can or other container and at the same time gradually add the calomel. Stir the two together with a stick and then pour back and forth from one container to another until all the seeds appear to be evenly coated and separate from each other. Place the mixture in the seeder and sow at once before it dries out. If allowed to dry out the calomel will flake off the seed and control will not be obtained; so make up each seeder-full just before using. It will be found necessary to open the outlet a little wider than usual to make sure that the right amount of seed is coming out as the bulk is increased by the calomel. Be sure to test this on a board or other surface before sowing.

We hope to improve the method by the use of certain adhesives for sticking the calomel to the seed so that sowing can be delayed for an indefinite time after the seed is treated, and also to work out a satisfactory and reasonably cheap method for similarly treating picklers which are sown at a much heavier rate than field onions.

As weeds interfere greatly with the growth of the onions and also with the success of control measures, every effort should be taken to keep them under control. It is also a good plan, so far as possible, to destroy by burning all infested onion bulbs at harvest time, as they are a source of danger for the following year.

ONION THRIPS

Thrips tabaci Lindeman.

After the onion maggot the onion thrips is the most destructive insect enemy of onions, and in dry, hot seasons sometimes causes very great loss. In a cool, wet season it is usually not abundant enough to do much damage, partly because such weather is in itself unfavourable to it and partly because drenching rains wash off and kill a large percentage of the tiny creatures.

The light-yellow to brown adult is very small, being only about 1/25-inch long. It has two pairs of very frail, feather-like wings fringed with hairs. (See Fig. 42.) With such wings the insect is not a good flier against the wind, but can fly fairly long distances with it.

The young or larvae have the same general shape of body as the adults, but are, of course, smaller and have no wings. They are either white or pale yellow.



Fig. 42.—Adult onion thrips, greatly enlarged. (R. Ozburn.)

Food Plants.—Onions are the favourite food plants; but cabbage, cauliflower, cucumber, tomato and, in fact, most truck crops are fed upon freely and often serve as secondary breeding plants. Weeds and grasses are also infested to some extent. Moreover, the thrips is common in greenhouses.

Injury.—Both adults and larvae attack the onions throughout the season and feed by rasping or tearing the tissues and then sucking the juices. Wherever they work a small white or silvery blotch appears. When the thrips are very numerous the whole field soon begins to show a whitish, bleached appearance and the leaves wilt and fall over as if struck by some sudden blight. The result is that the crop is either almost ruined or very much reduced in quantity, especially if the attack takes place early or moderately early in the season, when the plants are still far from mature.



Fig. 43.—Work of onion thrips. (After Horsfall and Fenton.)

Life History.—The winter is passed in the adult stage under piles of onion refuse, such as tops, screenings and culls, or among any green onions that have been left growing in the field. They also winter in dense or weedy places and in fields of alfalfa. Many, too, are in greenhouses, where they continue to breed all winter. In spring, soon after growth has begun, the adults in the outside hiding places become active and gradually find their way to onion

fields or often first to early cabbage and other plants, and later from these to onions. Greenhouses are also a source of infestation in spring. Eggs are laid in the leaves of onions or other host plants. The eggs are very small—too small to be seen by the naked eye—and are inserted by a saw-like ovipositor into the tissues of the plants. They hatch in about four days. In six or seven days more the larvae become full-grown and then enter the soil about two inches to pupate. The pupal stage requires an average of about four days. Hence the life cycle from egg to adult may be passed in two weeks. As the insects are present and breeding from May until October there are many generations in a season; thus, even though there may be only a few adults in May, the rate of reproduction is so rapid there may be countless numbers in July, August or September, if weather conditions are favourable.

Control.—The most important thing in control appears to be prevention. Leave no suitable places for the thrips to winter in, or destroy them in these places in spring before they become active. Hence in fall a complete clean-up should be made of the onion field, so that there will be no green onions left and no piles of tops or of culls or screenings. All these should be burned. In spring all headlands and all weedy and grassy places should be burned over carefully before the thrips become active. At the same time the thrips in greenhouses in the neighborhood should be destroyed by fumigating the houses several times at intervals of a week or ten days with tobacco or hydrocyanic acid gas, or by spraying with nicotine sulphate 40% and soap.

In addition it is wise, wherever it can be managed, not to grow onions near alfalfa fields or any kind of field likely to provide good cover for the thrips in winter. In the onion field itself the crop is likely to be worse infested if a practice is made of growing sets, as these come on earlier than the seed onion, and so the thrips get a start on them and then gradually spread over to the seed onions, often causing a much worse infestation than if there had been no sets. If, however, sets are grown it is wise to spray them very thoroughly as soon as the thrips are seen to be present with $\frac{1}{2}$ pint of nicotine sulphate 40% to 40 gallons of water to which has been added 3 lbs. of soap dissolved in boiling water. Common laundry soap or a soft soap may be used. The spraying should be repeated in seven to ten days to destroy the nymphs which will have hatched in the meantime from the eggs, (the eggs are not affected by the spray), and also to destroy adults which will have come from the pupae in the soil.

It is often recommended that the whole onion crop should be sprayed with the above mixture from time to time throughout the season. When the plants are young, spraying, if repeated in a week or 10 days, will do a great deal to prevent loss at that time of the year; but once the plants become large, it is not satisfactory, because the dense foliage then makes it almost impossible to do sufficiently thorough work to prevent large numbers of the thrips being left alive.

In spraying it is very important to use high pressure and to cover every side of the plant with special care, and especially to see that the liquid is driven forcibly right down into the centre of the plant, where many of the thrips are hidden in the axils of the leaves. For spray outfits which may be used in applying the mixture, see last paragraph on page 58 under Onion Maggot.

Dusting with nicotine dust will kill a good many of the thrips, but has not proven nearly so satisfactory as spraying.

In New York State Maughen* secured good control with crude chipped naphthalene. This was first run through an ordinary wire-door screen to remove lumps and was then applied once every seven or eight days during the period when thrips were increasing very rapidly and likely to do most damage, which in New York was chiefly the month of July. The best method of application was found to be by hand directly upon the plants so that some would remain on most of them and be sure to kill the young which are most common in the axils of the leaves. At each application 300 lbs. per acre were used.

Some recent experiments by Pepper** indicate that a much quicker and less wasteful method of applying the naphthalene may soon be worked out, and should help to make the control of this pest easier.

It is important not to forget that the richer the soil the better the plants withstand attack by thrips, hence it is a good plan to use commercial fertilizer on a poor soil and to prepare the seed bed as well as possible.

INSECTS ATTACKING PEAS

PEA WEEVIL

Mylabris pisorum Linn.

The pea weevil is the worst of all the insects attacking peas and has been responsible for great losses and for many farmers abandoning pea growing.

The adults are stout, oval, brownish beetles about 1/5 inch long with white and black mottling on the back. The larvae are stout, white little grubs and spend all their life inside the peas.

Food Plants.—Peas are the only plants fed upon.

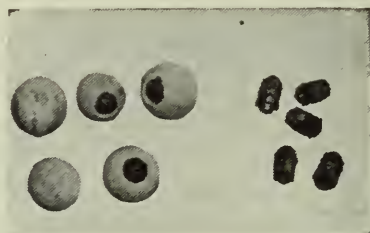


Fig. 44.—Pea weevils and their work, natural size.

Life History and Injury.—The beetles emerge from their winter quarters before or during the time the peas are in bloom. They feed to some extent upon the plants and then begin laying their eggs. These are yellow and are placed on the newly formed buds. On hatching the larvae are very small and work their way through the pods into the tiny peas within. The entrance holes soon heal over and the larvae feed on the interior until full-grown. Then they pupate just where they are. By the time the peas are ripe the pupae have changed to adults. When the plants are harvested a large percentage of the beetles remain in the grain when it is taken to the barn. Many come out during the threshing and hide in various places in the barn or wherever they can find suitable shelter nearby. The remainder stay right in the peas themselves until the next spring or early summer. Many peas, however,

*J1. Ec. Ent. Vol. 26, pp. 143-147, 1933, and Vol. 27, pp. 109-112, 1934.

**J1. Ec. Ent. Vol. 30, pp. 332-336, 1937.

are shed in the field during harvesting operations, especially if rain comes after the crop is cut and before it can be hauled away. Rain causes many of the pods to split and therefore to increase the number of peas left on the ground. In these shelled peas great numbers of weevils are often present. The majority of them soon come out of the peas and fly away to woods and other shelters, sometimes to a distance of two or three miles. Here they hide under loose bark or lichens on the trees or under moss and rubbish on the ground or any other suitable places. These outside weevils, like those in the barn, remain where they are until next spring when they fly to the pea fields and begin laying eggs. There is only one brood a year.

Control.—1. It is almost impossible to secure control, when the weevils are abundant, in any way except by all farmers in the vicinity giving up the growing of peas for a year or two. This starves out the insect because, as said before, its only food plant is the pea.

2. It is necessary to remember that many peas are left in the field after harvesting and these may contain numerous weevils. Hence, if hogs are allowed to run in the field immediately after the crop is off, they will, in the course of a couple of weeks, eat a very great number of the peas and thereby lessen the number of weevils. It is probable that plowing the ground 5 inches deep soon after harvesting and harrowing it to fill in any openings would bury the beetles so deeply that many of them would perish.

3. The crop should be cut on the green side and harvested, if possible, before rain comes. It should then be threshed promptly and the peas fumigated at once. For fumigants and directions on fumigating see under Bean Weevil, page 27.

4. Do not sow weevil-infested peas without fumigating them because they germinate poorly and some of the weevils will still be present and later emerge and attack the new peas.

5. From the fact that many weevils winter in woods it may possibly help some to locate the pea field as far away from woods as possible.

6. In the coldest parts of the province the weevils are almost always least numerous, apparently because of the greater degree of cold. Hence peas may often be grown with much greater safety in such areas. For this and other reasons New Ontario seems to be well adapted to pea growing.

PEA APHID

Illinoia pisi Kalt.

The pea aphid is a light green color closely approximating to that of the pea leaves themselves. In size it is small, not more than $\frac{1}{8}$ of an inch in length. It is very sluggish in movement. The mouth-parts are as sharp as a needle and with them it penetrates the surface of its food plants and extracts the juices from within.

Food Plants.—Peas, including sweet peas as well as garden and field varieties, are the favourites. In addition several kinds of clover, alfalfa, and vetch are attacked.

Injury.—The injury begins a week or more before the bloom, except on the earliest planted fields, has begun to appear, and it continues until the peas are beginning to ripen. During this period the aphids may become so numerous as almost to cover the plants, especially the blossoms, young pods, and

surrounding leaves. The result is that so much juice is extracted that many of the blossoms are dwarfed or unable to open, the young pods are stunted, and the crop ruined or greatly reduced in yield. It is not uncommon to see whole fields so worthless that they are not even cut. This is true of canning peas as well as of the ordinary field peas. Fortunately early sown fields usually suffer very little damage. We have seen them almost totally free from aphids when nearby later fields were swarming with them. It is claimed, and apparently rightly, that some varieties are much less subject to injury than others.

Control.—1. As mentioned above, early planting usually results in a very high degree of freedom from injury. Therefore wherever practicable the peas should be sown as early as seems safe. This, however, for canning factories would not be satisfactory, because they require peas to be coming in over a period of two or three weeks at least, otherwise they could not all be handled.

2. On a small scale, as in gardens or in half-acre or acre plots, fair control may be obtained by spraying with pure derris powder (guaranteed to contain 4% rotenone), 3 lbs. to 100 gals. of water or 1 oz. to 2 gals. In order that this may spread well and stick it is necessary to add $\frac{1}{2}$ lb. of soy bean flour or of skim milk powder to the 100 gals. of water or 1 dessertspoonful to 2 gals. and mix well before putting in the derris. Apply on a calm day or part of a day and try to hit the plants from beneath as well as above. The best time to apply is as soon as you can find any of the little green aphids on most of the plants and before any real damage has been done.

3. On a field scale it is difficult at present for a single grower to apply any material because of the cost of a satisfactory outfit. The writer is of the opinion that control will have to be done cooperatively or by the canning factories purchasing the outfit and the dust or spray and treating the peas at a definite price per acre. If the stand of peas is poor it will seldom pay to treat them because of the cost of material and of application, but if the crop is promising it should pay well to treat.

As to the best material to use, there is difference of opinion, some preferring nicotine as a dust or as fumes produced by feeding the nicotine into the exhaust pipe of an auto or truck, others preferring derris with a spreader, or a spreader and sticker. The large spray companies are testing out these materials and the outfits and trying to improve the methods used at present. So we may hope that in a short time a reliable means of control will have been standardized. Growers will then be able to unite in buying an outfit and the necessary material, or they may get the canning factory to do the work for them at a reasonable charge. Success will depend very largely on applying the spray, or dust, or vaporized fumes soon after the aphids can be found on most of the plants and before they have done any real damage. The writer has seen a nicotine vaporizer at work and was surprised to find that little damage was done by the wheels to the vines.

There are indications that it may be possible for the plant breeders to produce a strain of peas that will be resistant to the aphids and at the same time satisfactory in all other respects.

PEA MOTH

Laspeyresia nigricana Steph.

The larvae of the pea moth are small, pale yellowish caterpillars about $\frac{1}{2}$ inch long when full-grown. They feed inside the pea pods upon the peas,

eating out irregular holes and leaving a lot of frass and webbing in the pod. The presence of the frass and the feeding on the surface of the pea instead of beneath it easily distinguish the work of this insect from that of the pea weevil. Fortunately the pea moth in Ontario is important only here and there in a few localities, and varies greatly in abundance from year to year. It can scarcely be classed as a major pest of peas in this province.

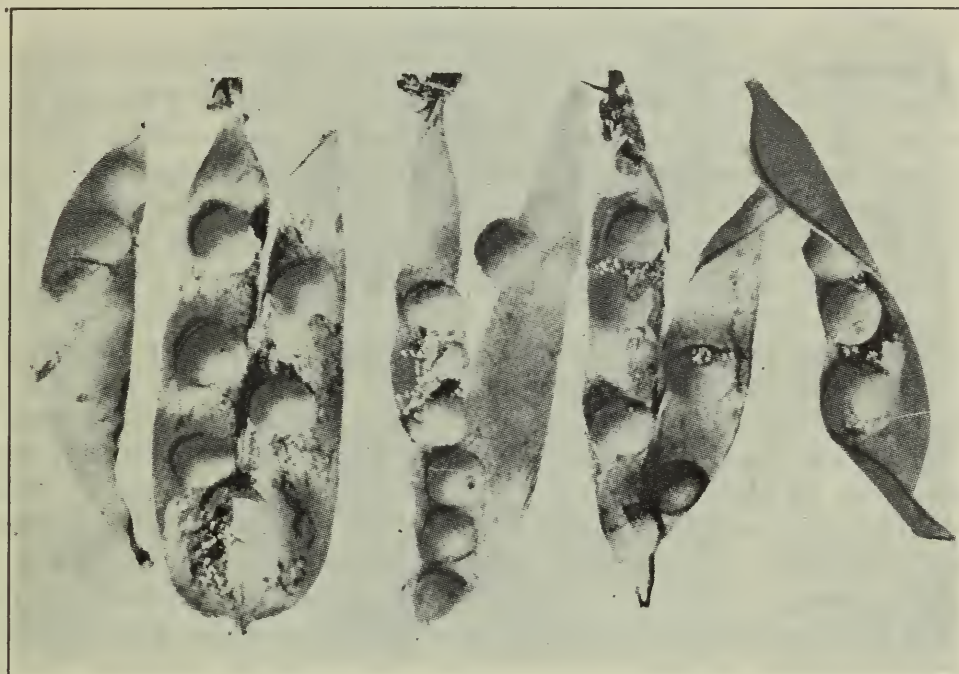


Fig. 45.—Work of the larvae of the pea moth. Note the castings.
(after R. Hutson.)

Life History.—The winter is passed in the larval stage in cocoons beneath rubbish or under the surface of the soil. In spring, when the pods are just forming, the moths, which are small and brown, emerge and lay their eggs singly on or near the base of the flowers. When the eggs hatch the little larvae bore through the young pods and attack the peas. When full-grown they go to the ground and form cocoons for winter. So there is only one generation a year.

Control.—Neither spraying nor dusting has given satisfactory results. The only things which seem to help are a rotation of crops, plowing deeply in fall, and threshing the peas as soon as possible after they are ripe so as to kill some of the larvae still present. In the case of garden peas the vines once they are no longer needed should be pulled and burned as soon as dry.

INSECTS ATTACKING POTATOES, TOMATOES AND EGG PLANTS

THE COLORADO POTATO BEETLE

Leptinotarsa decemlineata Say.

There is scarcely any insect better known to farmers and vegetable growers than the Colorado potato beetle. It occurs in every part of the province where potatoes are grown, even up in New Ontario. Everywhere it is the most destructive insect pest of potatoes, and is often so abundant that a great part of the crop would be almost ruined if the plants were not pro-

tected by spraying or dusting. Some years, however, it is so reduced in numbers by unfavourable weather conditions, predaceous enemies and parasites that very little damage takes place even though no control measures are used.

Food Plants.—Potatoes are much preferred to any other plant, but it is not uncommon to find tomatoes, egg plants and the common nightshade (*Solanum nigrum*) also attacked, though to a much less extent than potatoes.

Life History.—The winter is passed in the adult stage beneath the surface of the ground in the same field or plot where the beetles fed during the preceding summer. The depth to which they go varies from about 2 to 18 inches, large numbers being near enough to the surface to be turned up by the plough in fall or early spring. Towards the end of May the beetles emerge and soon fly away in search of potato plants. On finding these, they at once proceed to feed, mate and lay eggs. Egg-laying continues at intervals for a month or more. A single female may lay at least 1,000 eggs, but the average is probably less than half this number. The eggs are oval in shape, yellow to nearly orange in colour and are usually placed in clusters of about 5 to 150 on the underside of the leaves. The incubation period is approximately one week. The larvae soon after hatching begin to feed upon the leaves and eat small areas out of them. As they approach maturity they do much more damage and quickly strip the plants of all their foliage, leaving only the stem and main branches. It requires from two to three weeks for a larva to become full-grown. It then enters the ground from 1 to 6 inches, transforms there into a pupa and in a week or a little more, emerges as a beetle. Many of these new beetles, especially of those that emerge earliest, lay eggs and produce a second generation, but a large number, especially of the later emerging ones, do not lay eggs but merely feed a while and then enter the soil for winter. The larvae of the new generation also pupate in the soil and change into adults. These, like the other adults which did not lay eggs, feed for some time and then they too enter the ground for winter. Thus we have in Ontario one full generation and a partial second one. It is interesting to know that while most of the beetles which appear in the spring die before winter a number of them live through a second winter and even lay fertile eggs the next spring.

Control.—A few growers protect their plants by picking off the beetles, but this is such a slow labourious process that spraying or dusting is the regular method of control. Whichever of these two methods is used it should be applied as soon as the eggs have begun to hatch, because the larvae are much more easily killed while small than later, and by destroying them early the plants are saved from the injury that would otherwise take place.

Taking everything into consideration, spraying is to be preferred in most cases to dusting. The best and cheapest spray is 1½ to 2 pounds of calcium arsenate to 40 gals. of Bordeaux (4.6.40 formula) or to 40 gals. of water alone. For method of making Bordeaux see page 7. The benefit from using Bordeaux instead of water alone is that it is valuable in the control of flea beetles and especially of the potato leaf hopper. In wet weather it also helps against fungus diseases. Many persons, however, omit Bordeaux until later in the season.

Instead of the above strength of calcium arsenate some persons use 2 to 3 pounds of arsenate of lead, or 1 to 1½ pounds of paris green. The objection to the arsenate of lead is that it is more costly, and to the paris green that it

also is costly, tends to burn, and washes off easily with rain, and so has to be repeated oftener than either of the above.

The most common dust is composed of 15 lbs. of monohydrated bluestone, 10 lbs. of calcium arsenate, and 75 lbs. of hydrated lime. This mixture is



Fig. 46.—Colorado potato beetle larvae feeding on potato leaves, natural size. (Adapted from Britton.)

usually purchased from the spray companies already mixed. If the bluestone is not wanted each pound of the calcium arsenate may be used with 10 lbs. of hydrated lime alone. This is the cheapest dust and as satisfactory as any.

The number of applications with either the spray or dust will vary. Some years one, applied just as the eggs have begun to hatch, is sufficient, but usually a second in about 10 days is needed and sometimes a third in another week or 10 days. The main thing to remember is to get the first application on early and thoroughly and never to allow the insects to get a good start.

POTATO FLEA BEETLE

Epitrix cucumeris Harris.

The potato flea beetle is a small insect, about the size of the head of a common pin, with a black body and yellowish-brown legs and antennae.

The larvae are slender white worms with brown heads. When full-grown they are about $\frac{1}{5}$ inch long. Very few people ever see them because they remain underground all the time.

Injury.—Although not so destructive as the Colorado potato beetle, the flea beetle is one of our important potato pests. It is also some years quite injurious to tomatoes during the first week or two after the young plants have been set out. By far the greater part of the damage is done by the beetles themselves. These feed upon the leaves of potatoes and tomatoes in

May and June and when abundant make so many holes in them that the leaves are greatly weakened and sometimes turn brown and dry out. Later in the season, in August and September, potato leaves may sometimes again be attacked and severely riddled, though tomatoes are seldom fed upon at this time.



Fig. 47.—Potato flea beetle—adults and injury, natural size.

The larvae in this province have caused very little damage. They feed in the soil upon the roots of potatoes and to some extent of other plants too and perhaps also upon decaying vegetable matter. Occasionally they attack the tubers and make little tunnels a short distance into them or cause pimply growths upon the surface.

Life History.—The winter is passed in the adult stage under leaves, rubbish or any other kind of good shelter. In May the beetles come forth and may be found on the foliage of many kinds of weeds and other plants, though they seem to feed very little on these. As soon as potatoes or tomatoes are available they fly to them and feed as described above. Tomatoes are sometimes attacked in the hotbeds also. Egg-laying takes place in June and early July. The eggs are very small and white and are laid singly in the soil. The larvae on hatching feed as described above. When full-grown they pupate in the soil. From the pupae new beetles begin to emerge in late July and become most numerous about the first week in September. These feed upon the foliage until cold weather drives them into winter quarters. There is apparently only one generation a year.

Control.—Spray the plants carefully with either $1\frac{1}{2}$ lbs. of calcium arsenate in a 4.6.40 Bordeaux (for method of making see page 7), or with $1\frac{1}{2}$ lbs. of powdered derris (guaranteed to contain 4% rotenone) in 40 gals. of water. The derris will spread better and give a more uniform covering if about $\frac{1}{3}$ of a pound of either skim milk powder or of soy bean flour is added to the water slowly when the tank is about one-quarter full and the agitator is working, and the tank then filled and the poison put in. Either spray should be applied whenever the flea beetles either in the hotbeds or in the field are numerous enough to cause any appreciable damage. Usually one application is sufficient.

Dusts are sometimes used instead of sprays. The calcium arsenate-bluestone-hydrated lime dust, mentioned above under the Colorado potato beetle, or a dust made of 1 part by weight of the powdered derris mixed well with 7 parts of gypsum or of talc, may be used.

POTATO LEAF HOPPER

Empoasca mali Le Baron.



Fig. 48.—Potato leaf hopper adult, greatly enlarged. (R. Ozburn.)



Fig. 49.—Potato leaf hopper nymph, greatly enlarged. (R. Ozburn.)

The potato leaf hopper is a very small, green, sucking insect which both in the adult and nymph (immature stage) feeds on the under side of the leaves of potatoes. Here it pierces the tissues with its sharp beak and extracts the juice. When very abundant it may injure the plants considerably through the loss of juice. The main damage, however, is done in a very different way; namely, by the insect inserting a poison into the part where it feeds. This causes the leaves to turn yellow along the margin, usually at the tip first. Then the margin gradually turns brown and curls upwards and inwards. Often every leaf is thus affected, with the result that the entire plant soon dies. Whole fields some years are blighted in this way. This type of injury is called "hopperburn." Much of the disease which farmers previously called early blight or tipburn has now been proven to be hopperburn. Hot dry weather may be said to favour the disease, but chiefly because it favours the growth and increase of the leaf hoppers.

The adult leaf hoppers are only about one-eighth of an inch long and are pale-green with a few white markings, chiefly on the head and thorax. They leap and fly quickly.

The nymphs just after hatching from the egg are white to whitish-green and so small that they look like a mere dot. As they grow older and larger they become pale-green. They are much the same shape as the adults but have no wings and are smaller and paler in colour. They seldom leap but if disturbed run quickly to shelter.

How to Distinguish Leaf Hoppers From Green Potato Aphids.—Both have the same habit of piercing the leaves and sucking the juices, but while the leaf hoppers confine themselves almost entirely to the underside of the leaves, the aphids cluster not only on the underside but also on the leaf stem and tender upper portions of the plants. When disturbed they move very slowly compared with the rapid movements of the leaf hoppers. Aphids are also much broader and stouter in proportion to their length than leaf hoppers, and have a pair of little horn-like tubes towards the rear end of the body. Most of them have no wings, even in the adult stage.

Food Plants.—Potatoes seem to be the favourite food plants of the leaf hoppers, but they breed freely also on beans, sugar beets, raspberries, apples, alfalfa and to a lesser extent on many other plants.

Life History.—The winter is passed in the adult stage in weedy or grassy places or among brush or rubbish of any kind where they can find good shelter. In spring soon after vegetation has well begun they come out of their hiding places and feed on weeds or other plants until potatoes are far enough advanced to give them an abundance of food. Then they migrate to these and also to some extent to the other host plants mentioned above.

Soon after migrating, they lay their eggs in the leaf stems and leaf veins. The eggs are small and white and are inserted so deeply into the tissues that they are not visible. Egg-laying continues for a month or more. The eggs hatch in about 12 days and in 2 weeks or a little more the nymphs become full-grown and change into adults. This new brood of adults appears in late July or early August. Eggs are then laid during several weeks for another



Fig. 50.—Hopperburn injury to potato leaves, caused by potato leaf hopper adults and nymphs. (After Fenton and Hartzell.)

generation. There are thus two generations a year, or at least one full generation and a partial second. As implied above, no nymphs but only the adults winter over. During the summer it is customary for the adults to migrate from a field of old or dying potatoes to a field of healthy late planted ones.

Control.—Spraying the plants with Bordeaux mixture (4.6.40 formula) (See page 7) will give good control. The spray, however, must be applied to the underside of the leaves, because the insects feed there. It must also be done thoroughly, so that all the underside will be completely covered. The Bordeaux destroys the nymphs and drives the adults away. The first spray should be when the leaf hoppers begin to attack the plants, which will usually be when they are about 4 inches high, the second in 10 to 12 days, and the third after the same interval. Poison is not needed with the Bordeaux for the leaf hoppers, but should of course be added to the first and second applications for the Colorado potato beetle.

Fortunately, Bordeaux mixture will not only control the leaf hoppers but also the flea beetles and the late blight disease. For the last of these more applications have to be given in a wet season.

POTATO APHIDS

Several species of aphids attack potatoes, but by far the most common are the so-called "potato aphid" (*Illinoia solanifolii* Ashmead) and the peach or spinach aphid (*Myzus persicae* Sulzer). Most individuals of both species are green but some, especially of the former, are pink. They are small insects about $\frac{1}{8}$ inch long.

Life History.—Throughout the growing season all the aphids are females and all produce living young. As there are many generations in a season,

reproduction is very rapid when weather conditions or absence of natural enemies permit. Usually both wingless and winged forms are present. The latter often fly to other potato fields or to other vegetables or to weeds, and feed and breed there. In the fall of the year the first species mentioned above migrates to rose bushes, lays its eggs on them, and passes the winter there in



Fig. 51.—Potato aphids. (after Britton.)

the egg stage. The other species flies chiefly to peach trees and winters on these in the egg stage. In spring the eggs of both hatch about the time the buds are bursting. After feeding a couple of weeks on their respective winter hosts, both species produce winged forms which fly back to potatoes and to some extent to other plants.

Injury.—Aphids have very fine, sharp, piercing mouth-parts, which they insert into the leaves and tender stems of the potatoes and suck out the juice. When abundant they nearly cover the plants and are especially numerous on the under side of the leaves. Under such circumstances the great amount of juice extracted causes the leaves to become a sickly-yellow colour and often to die. However, it is only rarely in this province that potatoes are killed or even greatly weakened by aphids. The chief damage they do is of an entirely different nature; namely, the transmitting of two common potato diseases—mosaic and leaf roll. These diseases are introduced through the seed but once in the field spread, so far as is known, from plant to plant only by means of aphids. The aphids get the virus of the diseases into their bodies by feeding on diseased plants and when they insert their beak into a healthy plant they inject some of this virus into it and thereby inoculate the plant.

Control.—It is comparatively seldom that potato aphids are so abundant in Ontario as to require any artificial control measures. Wherever treatment is necessary the best method is to dust the plants thoroughly both from above and below with a $2\frac{1}{2}$ per cent. nicotine dust. The dusting should be done on a warm, calm day. Spraying with $\frac{1}{2}$ pint of nicotine sulphate 40 per cent.,

2 lbs. soap or $\frac{1}{2}$ lb. calcium caseinate to 40 gals. of water or of Bordeaux mixture is fairly satisfactory if applied well to both surfaces of the leaves, but is not quite so effective as the dust. (For method of making Bordeaux see page 7.)

It is impossible to annihilate aphids in any potato plot because the insects breed, as said above, on many other kinds of plants and will fly in from these and thus reinfest the potatoes. For this reason and also from the fact that the cost of dusting or spraying for aphids is high the best way to control mosaic and leaf roll is by careful inspection and roguing of fields and by planting only certified seed.

As one species of potato aphid winters on rose bushes it stands to reason that, if rose bushes were sprayed with nicotine in spring when their buds are bursting, or soon after, this would lessen the number of aphids that would fly from the rose to the potato.

TOMATO WORM

Phlegethontius quinquemaculata Haworth

The tomato worm is the large green worm with a horn at the posterior end. It is often found eating the leaves of tomatoes and of tobacco. These worms when full-grown are sometimes four inches long and about half an inch in thickness. Along each side of the body there is a row of large

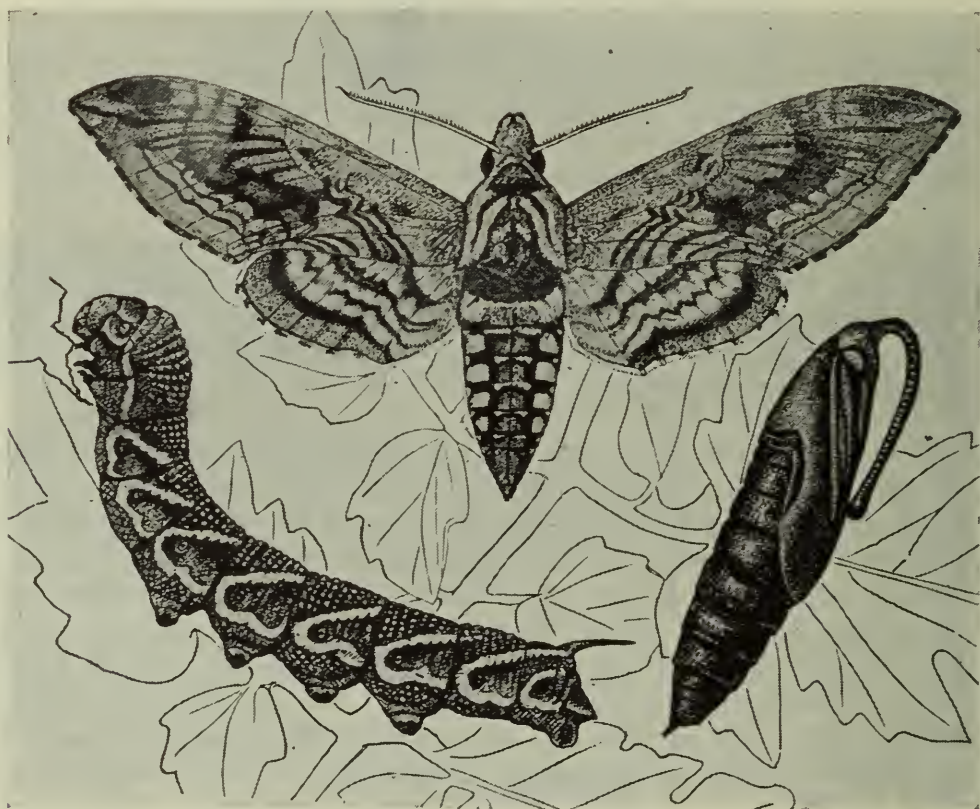


Fig. 52.—Tomato worm—adult, larva and pupa. (After Howard, U.S.D.A.)

V-shaped white markings which distinguish this species from others looking much like it. The worms are nearly the same colour as the leaves and so are difficult to see. As a rule they are not very abundant, but some years there are sufficient of them to defoliate many plants.

The adults are large hawk moths which fly around in the evening and at

night, insert their long, slender, sucking tube into the flowers of tobacco, thorn apple or other plants with long, tubular, bell-shaped flowers and suck the nectar out of them. The wing expanse of the moth is from four to five inches. The upper wings are grey, marked with irregular black lines. The hind wings are whitish-grey with a broad margin of grey and with heavy wavy black bands across them. The body is grey, spindle-shaped, stout and one and one-half to two inches long. On each side there is a row of five large yellow spots margined with black.

Life History.—The moths appear in June and lay their yellowish-green eggs singly on the leaves, usually on the under side. Egg-laying continues for several weeks. The eggs hatch in about a week and the larvae become full-grown inside a month. They then enter the ground, make an earthen cell and pupate. The pupa is dark-brown, about two inches long and half an inch thick and has a conspicuous handle-like structure at one end, which in the moth becomes the proboscis or sucking tube. The winter is passed in the pupal stage in the ground. Normally there is only one generation a year, but sometimes in a warm season in the south-western part of the province there is a partial second generation.

Control.—If there are only a few worms they may be picked off the plants by hand and crushed on the ground; if, however, they are at all numerous the best method is to spray the plants thoroughly with arsenate of lead 2 lbs. to 40 gals. of water, or with calcium arsenate 1½ lbs. to 40 gals. The spraying should be done while the worms are small and before they have done much damage. Spraying with an arsenical after the fruits are half-grown would be dangerous to consumers. Hence, if a spray at this time is needed, use derris 1½ lbs. to 40 gals. of water. Dusts give nearly as good results as spray. Use arsenate of lead 1 part by weight to 3 parts of hydrated lime, or calcium arsenate 1 part to 5 parts of hydrated lime, or derris (guaranteed to contain 4% rotenone) diluted with 6 times its own weight with gypsum, or talc or cheap flour, not with hydrated lime. Derris, as stated on several occasions above, is very little, if at all, poisonous to man.

RHUBARB INSECTS

THE RHUBARB CURCULIO

Lixus concavus Say.

The rhubarb curculio is a large slaty-black beetle with a long snout. It is about two-thirds of an inch in length and can readily be recognized by the large size, long snout and yellow powder, which in nature covers its body.

The larva is white, stout and about three-quarters of an inch long when full-grown. It is legless and has a brown head.

Food plants.—In addition to rhubarb the beetle attacks curled dock and in some places also thistles and sunflowers, but the writer has found it in this province only on rhubarb and dock.

Injury.—The injury to rhubarb is caused solely by the adults, for the eggs in the stalks either fail to hatch or the larvae die soon after hatching. During June and early July the beetles eat holes about one eighth of an inch deep here and there along the stems and larger leaf veins. Gum usually exudes from these holes and in most cases the affected area dries out and turns brown, though occasionally rot sets in. There may be a dozen or more injured places on a single stem, thus making it unsightly and unsaleable.

Such stems readily break with the wind or when being gathered. Fortunately the marketing season is usually well advanced before the beetles have done much feeding. In commercial plantations injury is usually rare, but on farms or in gardens in villages or towns where docks are present it is not uncommon.



Fig. 53.—Rhubarb curculio—(a) adult; (b) egg in curled dock, the surface being removed to reveal it; (c) feeding and egg-laying injury in curled dock, all natural size.

Life History.—The beetles begin to appear and attack the rhubarb and docks about the beginning of June. In a short time egg-laying commences and continues for a little over a month. The larvae from the eggs laid in rhubarb, as mentioned above, die before they do any damage, but from the eggs in docks they live and soon bore down through the stem to the ground. Here they continue to feed until full-grown, then change into pupae and about September the new beetles begin to emerge. These, after feeding a short time, go into winter quarters apparently under rubbish or leaves in the vicinity.

Control.—As the insect breeds entirely, or almost entirely, in docks the simplest method of combating it is to prevent docks from growing in the neighborhood of rhubarb. If the beetles are present and attacking rhubarb it is a good plan to leave the docks until all eggs are laid, which will be about July 15th, and then cut the plants with a spade or spudder several inches below the ground so as to be below where the larvae are situated. Then gather the docks and burn them as soon as they are dry.

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BULLETIN 394

MARCH, 1938

Ontario Department of Agriculture

Statistics and Publications Branch

Toronto, Ontario

DISEASES OF POULTRY

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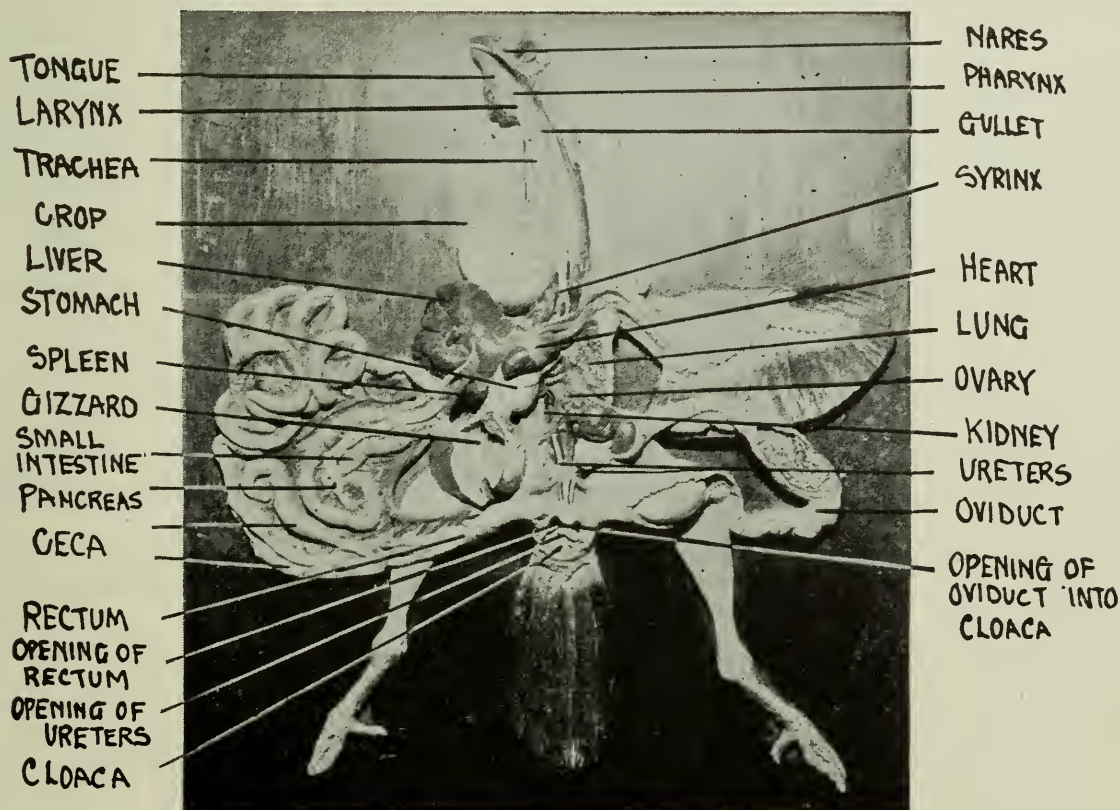


Fig. 1.—Model of hen showing principal organs.

FOREWORD

This bulletin replaces bulletin 305, "Diseases of Poultry", which was issued in 1924 by Ronald Gwatkin, D.V.Sc., Instructor in Poultry Diseases, Ontario Veterinary College, and in 1931 was revised by him and J. S. Glover, B.V.Sc.

The bulletin has served a useful purpose, and several thousand copies have been distributed in Ontario. Reports from poultrymen and farmers indicate that it has been of great value.

During the past few years many changes have taken place in connection with the control of poultry diseases, and it was thought that the time was ripe to publish a new bulletin.

The preparation of this work has necessitated a careful study of current literature, and acknowledgment is hereby given to all who have contributed bulletins for our assistance.

In this bulletin we have retained a lot of material contained in bulletin 305, including most of the illustrations.

Sanitation and feeding have been thoroughly studied for several years, and it is now generally conceded that the knowledge gained from these studies has helped considerably in combatting disease.

F. N. Marcellus, B.S.A., B.V.Sc., of the Poultry Department, Ontario Agricultural College has written the section on Sanitation, including that important subject, the fumigation of incubators. Dr. Marcellus is well known in Ontario as an authority on poultry ranch sanitation, and his advice given here should be carried out in detail.

The section on Nutritional Diseases has been prepared by H. D. Branion, B.A., M.A., Ph.D., of the Poultry Department, Ontario Agricultural College. Nutrition plays such an important part in the control of poultry diseases that it was considered advisable to include in this bulletin the latest authentic information available. This section, if carefully studied, should help to solve many of the poultryman's problems.

Information regarding diseased conditions in poultry flocks will be gladly furnished by this institution, and we will endeavour, as far as possible, to assist the flock owner to control ill health and mortality amongst his birds.

DISEASES OF POULTRY

INTRODUCTION

Each year poultry raisers are realizing more and more the economic importance of disease in their flocks. Although diseases of poultry, sanitation, genetics, housing, feeding and incubation are distinct branches of poultry husbandry, a knowledge of all of them is necessary in order to maintain a healthy, profitable flock. Each branch is so closely linked with the others that often a weak link in the chain results in disaster. This thought must be borne in mind by those reading this bulletin, which has as its object a brief discussion of the more important diseases encountered in Ontario flocks, and methods whereby such diseases may be prevented or controlled. Certain diseases that are quite common elsewhere have not as yet made their appearance here, and some diseases that are very wide spread some years, are rarely encountered in others.

Diagnosis of Disease: In order to control the death rate in a flock it is obvious that the first step is recognition of the cause of death. No line of treatment, where such exists, can be intelligently recommended unless the cause is known. Quite often an accurate diagnosis at once suggests the remedy. This frequently requires some skill and experience, and a comprehensive knowledge of healthy organs and parts, and changes that occur in them when diseased. In many instances a complete history of the case is of valuable assistance.

Poultry Disease Laboratory at the Ontario Veterinary College: A laboratory is maintained here for the purpose of assisting the poultry owner in combatting his problems in relation to disease. When help is needed along these lines birds may be sent in for examination. It is always more satisfactory to forward more than one bird to the laboratory, as quite often, when only one bird is sent, it does not represent the flock trouble. More than one disease may exist in a flock at the same time. Also, when possible, sick birds should be sent rather than dead ones, as putrefaction sets in very quickly in fowl, and signs of disease that would be quite evident in fresh material would probably be masked by putrefactive changes. If suitable living birds are not available, the dead birds should be packed in such a manner (wrapped in cheesecloth and packed in ice and sawdust in the hot months) that they will arrive in a fresh condition. Information that should accompany the specimens include the age of the birds, how long they have been sick, if any others in the flock are affected, if raised on the premises or purchased recently, if in confinement or on range, symptoms observed, condition of houses and runs, and the mortality during the outbreak of the disease.

The birds should be sent, express prepaid, to the Ontario Veterinary College, Guelph.

As a rule reports are sent out within one or two days after receipt of the specimens, but where a bacteriological examination is deemed necessary a complete report cannot be prepared quite so quickly.

Medicinal Treatment for Sick Poultry: Poultry do not readily respond to medicinal treatment, and poultry pathologists and poultry husbandrymen realize that most treatments are only temporary. An apparently "cured" bird that has suffered from an infectious disease may remain a "carrier" of that disease and spread it to other birds in the flock. It is also likely that it will always lack vigour. Unless the bird is a valuable one treatment is not worth the time or money, and if only a few birds are affected it is wiser to dispose of them. When a large number are affected with some simple condition, it may be found possible after the nature of the disease is ascertained that the flock can be treated with some remedy that can be added to the feed or drinking water. No attempt should be made to treat sick birds until a correct diagnosis of the condition has been made.

Prevention of Disease: Prevention is the keynote of success, and the poultryman should endeavour to feed, house and look after his flock in a hygienic manner, striving always to prevent disease gaining a foothold, watching closely for the earliest sign of any trouble, and at once removing affected birds. If the disease turns out to be non-infectious no harm has been done, but if it is of an infectious nature the steps taken will probably prove to be a sane economic measure. As fowl live very closely the spread of infectious diseases in a flock is often very rapid, due quite largely to their manner in feeding. In case of an outbreak of an infectious disease, thorough cleaning and disinfection of the houses, utensils, runs, etc., must be carried out, as the droppings of infected birds are a common source of spread in many diseases. Birds that have died, no matter if it is known or not what the disease was, should be burned or buried deeply. (We prefer to recommend burning as too often the burying of infected material is inefficiently carried out.) If left lying around they may be the means of other birds contracting the disease.

Quarantine: It is important that new birds introduced into a flock, or birds returning from exhibitions or egg-laying contests, should be quarantined for a period of three weeks. The quarantine house should be preferably some distance from the quarters of the other birds and should be looked after by someone who does not go among the remainder of the flock. Care must be taken that possible infection is not carried on the hands, clothing or utensils from the quarantine building to others.

SANITATION AND HYGIENE

There are too many people to-day depending on curing disease and parasitic invasion of their flocks. Much more could be accomplished if such efforts were directed at prevention. This simply means more careful attention to those factors which contribute to the introduction and spread of disease and parasitism. The flock owner must endeavour to avoid those conditions that would have any tendency to weaken the birds physically, thereby predisposing them to disease attack.

A special effort should be made to keep the poultry plant or farm in a thoroughly sanitary condition. Muddy yards and stagnant pools or seepage water are to be avoided. Clean the pens as often as necessary to keep them in a sanitary state. Do not throw feed on the ground or floor of the pen where these are badly fouled with the droppings. Drinking utensils soon become dirty and slimy, particularly in the warm weather, and are a danger point in the spread of disease.

Feeding: Feed used for poultry should be of good quality. Mouldy or spoiled feed of any kind produces diarrhoea in mature birds and is often fatal where fed to chicks. New grains — wheat, oats and corn — harvested in late Summer and early Fall sometimes carry a toxic factor that produces an acute dystentery and may even cause considerable mortality. Fortunately this toxic condition disappears before the end of October. Frosted vegetables, such as cabbage and mangolds, cause serious bowel trouble and are best avoided. Other kinds of spoiled feed disturbances are common, but any and all of them react on production and tend to increase mortality. Nutritional disturbances sometimes occur, but these are discussed elsewhere. For general information on feeding the reader is referred to Bulletin No. 379 on "Farm Poultry". This can be obtained from the Department of Agriculture, Parliament Buildings, Toronto.

Housing: The proper housing of birds is important. Over-crowding frequently occurs although it causes stunting of growing birds, retards production and lowers the birds' vitality. In most houses birds will require four square feet of floor space each. Damp pens adversely affect the birds' vitality and provide ideal conditions for the propagation of disease infections. Dampness is the result of over-crowding or poor ventilation and, in making provision for the latter, draughts must be avoided. Sunlight, being one of the best and cheapest agents we have to destroy disease organisms, should be freely admitted to the pens. The brighter the pens, the happier and hence more productive are the birds. Unnecessary fixtures are better left out of the house as they collect dirt and increase the labour of cleaning.

Range: Rotation of chicken range is important. Where possible follow a four year rotation. If land is not available for an annual rotation one may manage with a monthly rotation or frequent cultivation of range in continuous use. Frequent seeding with oats or other grains in this latter case will be advisable. It will help to cleanse the soil and provide some excellent pasture. There are some indications that growing birds having an abundance of tender, succulent green pasture, such as suggested, may be less susceptible to intestinal parasitism.

Feeding and drinking equipment used on the range should be moved four or five feet twice a week throughout the Summer. This keeps the surroundings more hygienic and there is less chance of spilled feed getting mixed with the accumulated droppings than would otherwise occur.

Disease Control: Disease troubles run in cycles. They are perhaps most prevalent in the late Fall and early Winter (October to February). It is also well to remember that the more outside contacts or the more mixing from pen to pen in the flock, the more trouble from disease.

It is important in any disease control programme that the flock owner should endeavour:

1. To prevent the introduction of infection into the flock;
2. Maintain his flock in such physical condition as to conserve their natural resistance to disease;
3. Control, and if possible eradicate, infections and parasitic infestations which do occur.

Avoid Introducing Infections: Birds returning from Shows or Laying Competitions, or stock purchased, should be placed in quarantine for three weeks before mixing them with the flock. When buying stock it is wise to check care-

fully for any evidence or recent history of any disease troubles in the flock from which purchases are to be made. In buying new stock it would possibly be safer to purchase hatching eggs, baby chicks, or partially grown chickens, off the range in midsummer, rather than mature stock in the Fall. Colds frequently develop in birds otherwise in good health when transported in bad weather.

The greatest care should be taken in allowing itinerate poultry buyers and truckers into the poultry pens. Crates which have been used in the general live poultry trade should never be taken near the houses or yards. Buyers and their equipment contacting flocks throughout the community frequently handle diseased birds and may readily carry such infections into a healthy flock.

In operating a hatchery provision is necessary for proper disposal of incubator waste such as egg shells, dead germs, dead chicks and chick down. This material may be loaded with infection and should be burned. It must never be scattered over the fields where poultry is at any time likely to be ranged.

Conditions Predisposing Birds to Disease: Over-crowding is possibly one of the worst crimes committed by poultry men and women at the present time. It occurs regularly with young chicks, frequently with growing stock and often in the housing of adult birds. The practice causes stunting and permanent injury to the birds and, in addition to the damage to growth and production, weakens and predisposes them to disease.

Poor feeds or poor feeding practice will usually cause trouble. Improperly balanced rations, absence or insufficient amounts of essential nutrients, such as some of the vitamins, will help lower the birds' resistance to bacterial invasion. On the other hand, if some of those materials necessary in only small amounts are given in excess of the birds' requirements, the results may be equally as serious. Frequent or even occasional dosing of birds with drugs, some of which may be actually injurious, cannot be too strongly condemned.

Control and Eradication: It is not always possible to prevent introduction of disease into a flock. Wild birds, rats and other animals may carry infection from one farm to the next. Where an outbreak does occur precautions should be taken immediately to control its spread through the flock and, if possible, eradicate it completely. It is well to remember, however, that many of our common poultry diseases are carried over the Winter in so-called recovered cases. These, contacting chicks directly through cohabitation of the same in houses or on range, or indirectly by the attendant, may infect the young stock and so complete the cycle. Under such conditions the flock owner may do repeated cleaning and disinfecting and still have trouble.

The land used for growing young stock should be entirely separate from yards or range used by the adult birds. Manure or litter removed from the pens of mature stock should never be scattered on land to be used as chicken range for two years after.

In some diseases the infective organism may be extremely difficult to eradicate from the premises. In such cases it may even be advisable to leave the building vacant for several months after cleaning up. In case of possible carriers in the flock, slaughter of the entire flock may be advisable as the quickest way to get rid of the infection.

Prompt action is very important in dealing with sickness in the flock. On the first sign of trouble the affected bird or birds should be removed. If the trouble is later found to be infectious the pens should be thoroughly cleaned. Fine chaff,

sawdust or shavings may be used on the floor, removed daily and burned. As the droppings usually carry infection they should be removed daily. Feed and drink must be kept free from contamination with such materials. Birds that have died should be burned.

How to Disinfect Poultry Houses: Preliminary cleaning — remove all litter; if infection is present place the litter in bags and burn; remove the roosts, nests or other loose fixtures, scrape and scrub these and leave them in the sunshine; empty and clean all water utensils, grain, mash, grit, shell and bonemeal hoppers and destroy or cook the contents. The interior of the house must be thoroughly swept down and the material thus removed burned. Where a straw loft is used the straw should be completely removed and destroyed. The floor will probably require soaking and scraping. If one has a hose and water pressure the entire inside and floor is then thoroughly washed off. If a hose is not available then the floors and walls should be scrubbed with a hot lye solution.

Disinfection: When the house is dry spray it with some suitable preparation, such as thin, strained whitewash made with quick-lime to which is added 5% of crude carbolic acid or 2% of compound solution of cresol or other good disinfectant. The lime, as well as having some germicidal action when fresh, has the advantage of showing whether any parts have been missed. All cracks should be filled up with the spray. A brush may be used but does not get the fluid into the cracks so efficiently. Roosts, boxes, etc., should be soaked in the solution or thoroughly sprayed before replacing.

If an infectious disease has been present it is well to repeat the spraying a second time, after the first application is dry. The runs, if not too large, should be covered with quick-lime and spaded under.

Cleaning and Disinfecting Incubators

Cleaning: Thoroughly clean out the machine, scraping from the inside, bottom and sides any adhering dirt. Scrub the interior with hot water to which may be added Gillett's Lye, one tablespoonful to a gallon of water, or one of the common coal tar disinfectants in the recommended strength. When the machine and trays have been thoroughly cleaned in this way, they are ready for disinfection.

Methods of Disinfection

Liquid: Thoroughly saturate the interior of the machine with any liquid disinfectant. The strength of the solution varies with the brand used but one should be careful to see that the solution used is well up to the strength.

Gas: In case one does not wish to use a liquid disinfectant, Formaldehyde Gas may be used. Its application is easy and efficient when properly applied. For this use 1 gram Potassium Permanganate crystals to 1.5 cubic centimeters of Commercial Formalin to each cubic foot of space in the machine. To apply, prepare the required quantities of the two drugs for your machine. Place the Potassium Permanganate in a wide, flat, enamelled vessel in the bottom of the machine, as the material will boil and spatter when the Formalin is added. When all is ready, add the required quantity of Formalin solution from an open topped container, as this must be done quickly. As soon as the Formalin is added close up the machine. Leave the machine closed for at least fifteen minutes, after which time open the doors and allow the gas to escape.

For most effective results the machine must be warm and the humidity on the wet bulb thermometer 85 degrees or better 90 degrees. Eggs may be gassed in the machine at any time EXCEPT FROM THE 24TH TO THE 84TH HOURS OF INCUBATION; or in other words, eggs may be gassed during the first 24 hours after setting. Otherwise they must not be exposed to the above concentration of gas until after they have been in the incubator 3½ days.

Frequency of Disinfection: Machines should be disinfected after each hatch. This, where properly done, prevents any accumulation of infection from one hatch to another. WE DO NOT ADVISE GASSING CHICKS.

POST-MORTEM EXAMINATIONS

Very often it is impossible to decide what is the matter with a bird, or birds may be found dead that were not previously known to be sick. In these cases a careful post-mortem examination may reveal the cause. It must be remembered, however, that fowls may die of such conditions as heat exhaustion, from some lesion in the heart that escapes notice, from excessive fat in the same organ, or to some apoplectic condition, in which cases no changes will be noticed.

Instruments and Methods of Opening: If many post-mortem examinations are to be made the following instruments will be found valuable: A pair of heavy bandage scissors, a sharp knife, a pair of fine scissors, and, if desired, a pair of thumb forceps. The dead bird should be carefully examined for any external conditions. Then lay it breast upwards on a piece of board, and extend and drive a nail through each wing and foot. This holds the bird firmly and facilitates the making of a careful examination. Make an incision through the skin from the underside of the beak back to the vent and remove the skin down to the level of the board, as shown in Fig. 2. Then carefully cut into the abdominal cavity above the cloaca, insert the heavy scissors, blunt point inside, and cut through bone and muscle right to the front of the body. Do the same on the other side and remove breast bone and abdominal wall taking care not to injure the liver, heart or other organs. These are carefully freed from the peritoneal and other attachments by means of the knife while the abdominal wall is being lifted up, leaving them exposed to view as in Fig. 3. While it is not necessary to remove the skin before opening the bird, the small amount of time required for the operation makes it very desirable, banishing, as it does, the annoyance of feathers getting into the body during the examination, and permitting the examination of the subcutaneous tissues.

Examination of Organs: Before removing any of the organs they should be examined in position, and the presence of fluid or any other abnormal condition noted, such as blood clots, tubercles, yolk concretions and tumours.

Then the liver is examined. It should be dark chocolate brown, firm, smooth and shiny. In disease it may be enlarged and soft, contain tubercles, be changed in colour or consistency, or have greenish areas, or tumours may be present.

On turning back the liver and gizzard the spleen and gall bladder can be observed. The spleen is a small, somewhat round, dark red body normally, but may be much enlarged and congested in acute bacterial infections, or large and mottled in certain forms of leucosis or tuberculosis. The gall bladder is a small sac attached to the right lobe of the liver, and contains green bile.

The heart and lungs are next examined and removed. The heart should be examined for size, excessive fat, and the condition of the covering and lining

membranes and heart muscle. The lungs are bright red and should be examined for congestion or pneumonia. Congested lungs are dark red and will float, while pneumonic lung tissues will sink in water.

The trachea (windpipe) and bronchi should be opened with fine scissors and the presence of parasites, false membranes, or other exudate noticed. The condition of the larynx (opening to the windpipe) and pharynx (throat) is also observed, and the roof of the mouth can be removed for examination of the nasal passages if necessary.

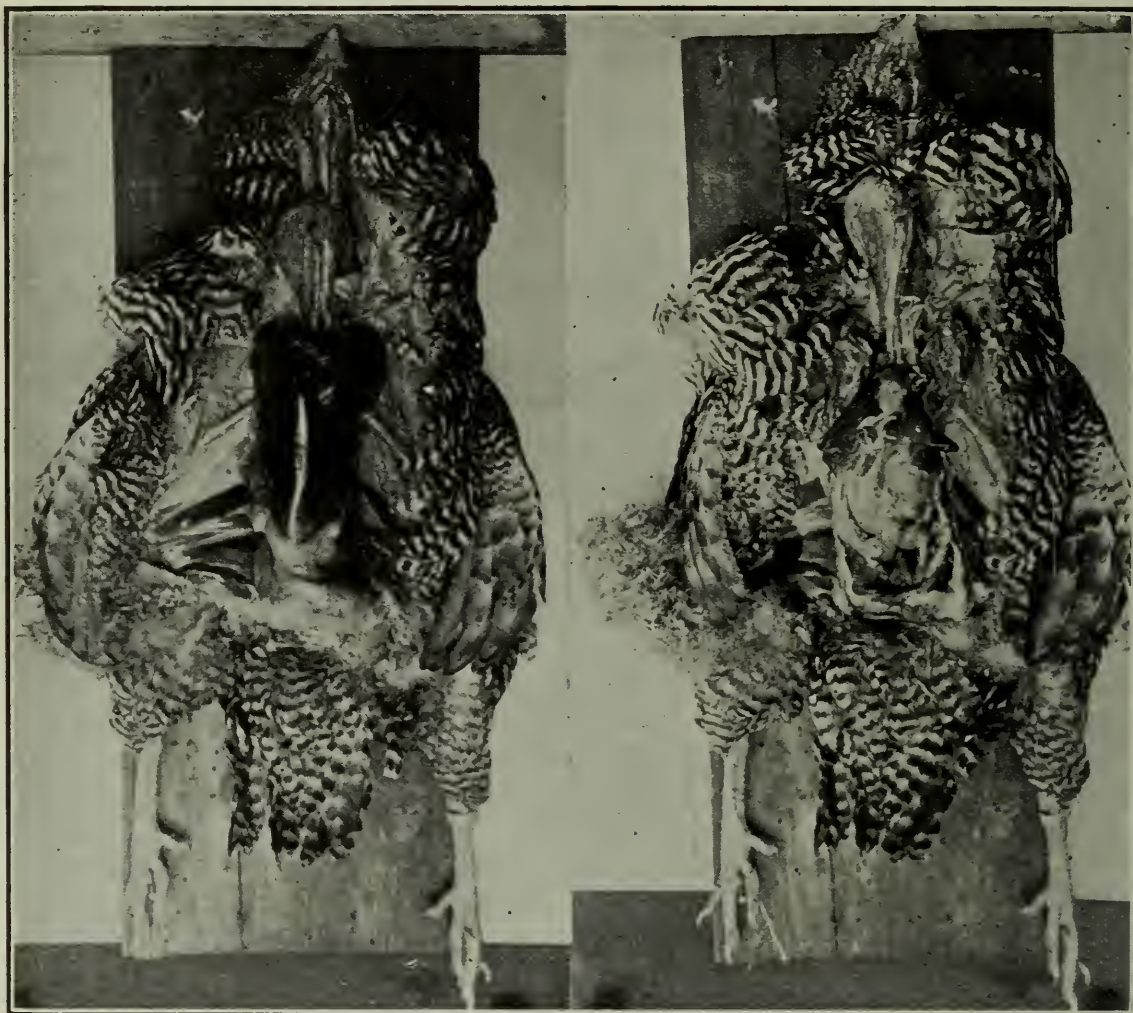


Fig. 2.—Fowl in position for examination Fig. 3.—Same fowl after removal of breast with skin removed. (After Gwatkin) bone and abdominal wall. (After Gwatkin)

The intestines are now examined externally for tubercles or signs of inflammation, and should then be opened up with the fine scissors and examined for parasites and the condition of the mucous membrane lining it. Examine the cloaca and remove the intestines out of the way, if this has not been done before opening them.

The kidneys and reproductive organs can now be seen. The kidneys are normally dark red in colour. Changes in colour and size are to be looked for. The ovary, oviduct and ureters are next examined for tumours, concretions, inflammation or rupture, and the appearance of the urates in the ureters.

The peritoneum, the membrane lining the abdominal cavity and covering the organs, should be thin, glistening and transparent. When thickened or opaque it indicates inflammation (peritonitis).

NUTRITIONAL DISEASES

Proper nutrition is very essential in maintaining the health and well-being of poultry. Proper nutrition can only be achieved by feeding rations which are balanced in all those nutrients required by growing chicks or by laying birds, as the case may be. These nutrients are: water, protein, carbohydrates, fat, minerals and vitamins. Protein is the tissue builder required for the replacement of worn out tissue and the construction of new tissue. It is also required by laying birds for the production of eggs. Carbohydrates and fats are the fuel foods which are oxidized to supply energy and the production of heat. Minerals are found in the skeleton and in all organs, tissues and fluids in the bird's body. They are also required for egg shell formation. Calcium and phosphorus are needed for bone formation and for egg shells. Iodine is required for the proper functioning of the thyroid and the prevention of goitre. Iron is a necessary constituent in hemoglobin, the red-coloured material in blood. Salt is also needed. Poultry require vitamins A, B₁, B₂ or G (flavin), B₄, D, E, K, the gizzard factor and the antipellagic factor.

Certain diseases are the result of a deficiency of some of these essential ingredients in the ration, or of an improper balance between some of these nutrients, or occasionally of an excess of some these substances. When the ration fed to poultry is unbalanced or deficient in any of these nutrients, or if the birds are not fed sufficient amounts of a balanced ration, they are more susceptible to disease organisms or parasites.

Certain diseases are caused by a deficiency of some specific nutrient, particularly vitamins.

Vitamin Deficiency Diseases: Although poultry require at least eight vitamins, only vitamins A, B₂ or G, and D need consideration since the other vitamins are supplied in adequate amounts by the feeding stuffs commonly used in poultry rations. In other words, a deficiency of these other vitamins rarely, if ever, occurs under practical conditions. Although these vitamin deficiency diseases can be cured, if observed in time, by feeding the missing vitamin, it is doubtful if such recovered birds are a source of profit in the flock. Prevention of the disease by adequate rations is a much better practice.

Vitamin A Deficiency — Nutritional Roup: This condition is due to a lack of vitamin A in the ration, as furnished by cod liver oil and other fish oils, or by provitamin carotene or cryptoxanthine, supplied by good pasture, green feed or green feed substitutes such as alfalfa, alfalfa meal and so forth, and by yellow corn.

Symptoms: Young chicks do not grow at the normal rate. They become semi-paralyzed, exhibiting muscular incoordination. Finally they can no longer walk and death soon ensues. There is a lowered resistance to infection and little white pustules may appear in the mouth, pharynx and oesophagus; the eyes are usually sore but typical xerophthalmia may not develop. The kidneys and ureters are enlarged and become greyish white in colour due to an accumulation of urates. The blood uric acid rises above normal. In mature birds egg production and hatchability are decreased. The same symptoms as found in chicks occur, but xerophthalmia is more common. The eye becomes swollen and filled with cheesy material. Patches of cheesy material may be found in the mouth and respiratory passages. The disease has the same general appearance as ordinary roup, hence the name 'nutritional' roup.



Fig. 4.—The characteristic ophthalmia of vitamin A deficiency. Note the swelling of the eye due to an accumulation of pus as a caseous material. This condition should not be confused with ordinary roup. (After Beach, California)

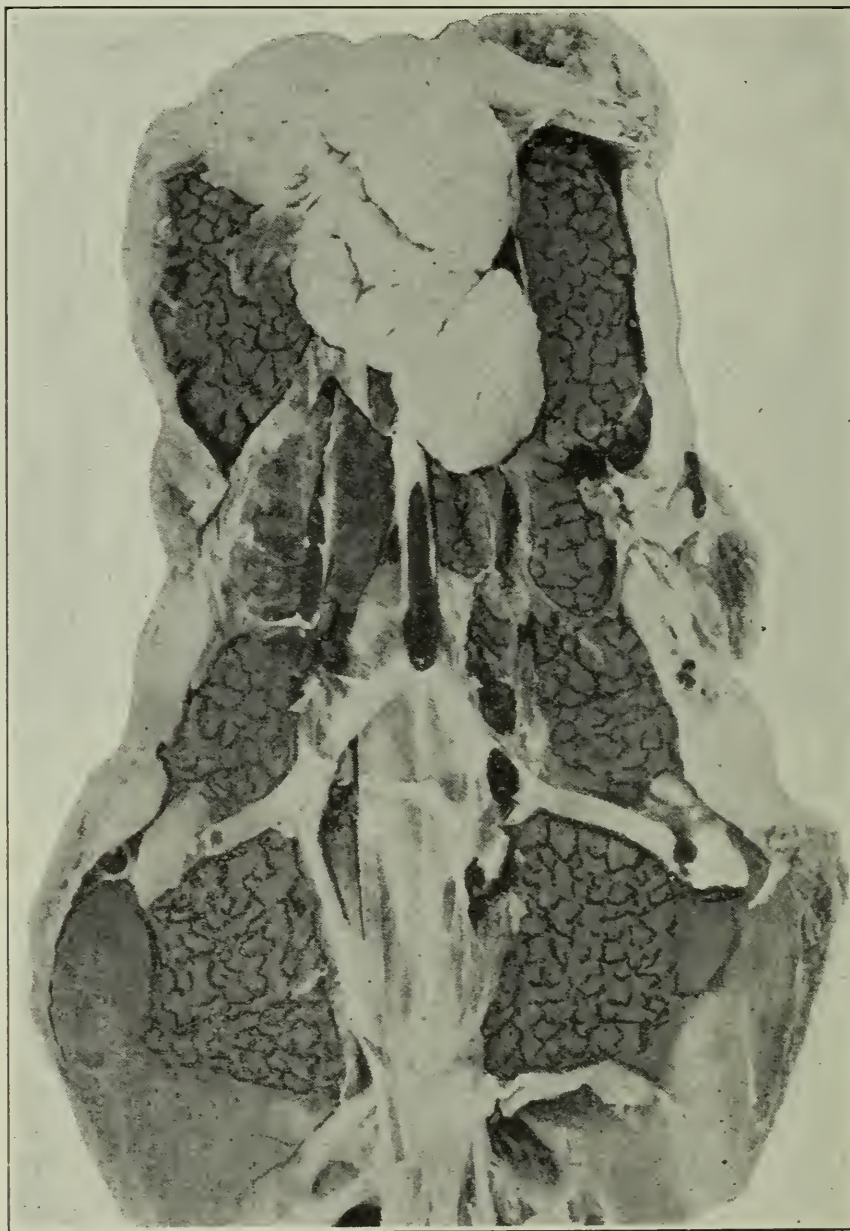


Fig. 5.—Kidneys of a fowl injured by vitamin A deficiency. The greyish colour and spotting is due to the accumulation of urates. (After Beach, California)

It is rare for a marked vitamin A deficiency to occur under modern feeding conditions, since the amount of cod liver oil generally incorporated into poultry rations ($\frac{1}{2}$ to 1 per cent) will meet, or almost meet, the vitamin A requirement, and most rations contain some green feed and yellow corn in addition. A partial deficiency may occur during hot, dry summers which result in a shortage of pasture and green feed, particularly in birds on range without cod liver oil in the ration.

Treatment: The treatment consists in supplying the vitamin, either by cod liver oil or other fish oils, or by green feed or green feed substitutes, in the ration fed to the afflicted birds. Chicks actually require about 150 International units of vitamin A per hundred grams of ration or about 680 units per pound (a pound equals 453.6 grams) to prevent the disease. To provide a margin of safety it is better to feed a ration containing 300 units per hundred grams. Similarly, a ration (mash and grain) fed to laying birds should contain about 700 units per hundred grams for best results.

Vitamin B₂ or G Deficiency: This disease is due to a lack of vitamin B₂, sometimes called G, in the ration. This vitamin is now known to be riboflavin, a greenish fluorescent pigment present in milk, liver, whey, green feed and good pasture.

Symptoms: Flavin is required for growth. Chicks also require flavin to prevent nutritional paralysis. This is a disease in which the chicks are semi-paralyzed and walk on the hocks (tibio-metatarsal joint) with a characteristic inward curvature of the toes. The vitamin is an important factor in hatching rations.

Treatment: Flavin should be provided by including some source in the ration. Milk is one of the best sources. A chick ration should contain about five percent of dried milk or its equivalent, whereas the mash fed to laying birds whose eggs are to be used for hatching should contain about ten percent of dried milk. Meat and fish meals are, in general, poor sources of flavin. Chicks suffering from nutritional paralysis often recover spontaneously, without treatment.



Fig. 6.—Nutritional paralysis. The birds are semi-paralyzed, walking on the hocks. Note the characteristic inward curvature of the toes. (Original)

Pellagra or Dermatitis: A deficiency of some other part or parts of the original vitamin B₂ results in pellagra or dermatitis. This vitamin is known as the antipellagic, antidermatitis or filtrate factor. In general, this vitamin is also found in those feeds which supply flavin.

Symptoms: The disease is rarely found under practical conditions. In chicks suffering from pellagra the growth is slowed and wart-like growths or encrustations

appear at the corners of the mouth, the eyelids become granulated and stick together. The skin between the toes and on the bottom of the feet becomes hardened, cracked and sore. Usually there is a retardation in feathering or a loss of feathers, particularly around the neck. This disease has not been observed in matured birds.



Fig. 7.—Pellagra in a chick. Note the wart-like scabs at the corner of the mouth, the granulated appearance of the eyelids and the cracking and hardening of the skin between the toes. Feather development is slow. (After Norris, Cornell)

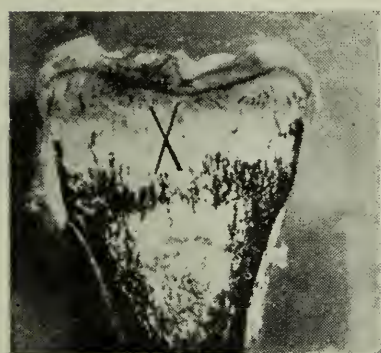
Treatment: The disease is so rare, under ordinary conditions, that it has been suggested that there may be other predisposing factors in the isolated outbreaks which have occurred. Hence, no treatment, other than the provision of a good, adequate ration, can be suggested at present.

Vitamin D Deficiency, Rickets, Leg Weakness: A deficiency of vitamin D results in the bone disease rickets, sometimes called leg weakness, in growing chicks. In order to develop good, strong, well-calcified bones, three nutrients are necessary. Bone consists largely of calcium and phosphorus, so these two minerals must be supplied. Vitamin D is also necessary in order that these minerals may be properly utilized. A deficiency of any one of these three ingredients in poultry rations will result in soft, brittle bones. Vitamin D and calcium are the two most apt to be lacking. A deficiency in vitamin D or of calcium will result in the same general symptoms and hence if the disease occurs in a flock it is necessary not only to check on the supply of vitamin D but also the supply of calcium, and occasionally phosphorus. The mineral requirements are discussed under mineral deficiency diseases.

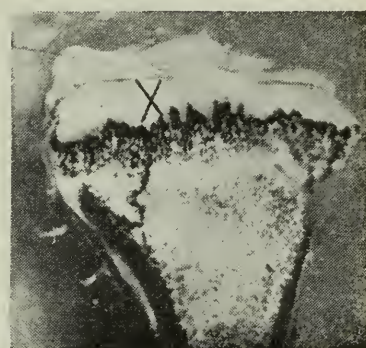
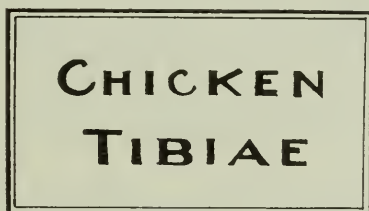
Vitamin D is supplied by cod liver oil and other fish oils. Birds also receive vitamin D through the action of the ultra violet light in direct sunshine. This ultra violet light acts upon some substances, originally considered to be ergosterol but now believed to be a derivative of cholesterol, present in the skin and converts it into vitamin D. To receive sufficient ultraviolet light, birds require about two hundred hours of sunshine per month. This amount is only received during the late Spring, Summer and early Fall months. During the remainder of the year it is necessary to include cod liver or other fish oils in the ration. Ultraviolet light will not penetrate ordinary window glass so a deficiency in vitamin D must be especially guarded against in birds under confined conditions.

Symptoms: Rickets seldom occur in chicks under four weeks of age. The affected birds walk with a wobbly gait and stiff legs. The joints become enlarged and the bones deformed, particularly the leg bones and the sternum or keel

bone. The beak is often soft and rubbery and growth is slow. In mature birds egg production and hatchability are decreased. The sternum may be crooked and the leg and wing bones are often brittle so that fractures occur. This disease is seen more often during the Winter months in flocks which are laying heavily. Slight lameness or paralysis may occur. It appears to be chronic in form, disappearing and returning in a few days. If the deficiency is severe, complete paralysis and death ensues.



1- SEVERE RICKETS



2- RICKETS



3- SLIGHT RICKETS



4- SUB-NORMAL



5- NORMAL

Fig. 8.—Sections of leg bones of chicks, showing varying degrees of rickets. The part of the section which is stained black is good bone. Note the widened band of cartilage (marked x) in the chicks suffering from rickets due to a lack of vitamin D. (After Baird)

Treatment: Chicks or laying birds suffering from a lack of vitamin D should be allowed out in the sunshine. During the early Spring, late Fall and Winter months poultry rations should contain cod liver oil or other fish oils. Chicks require about 25 International units of vitamin D per hundred grams of ration to prevent rickets, but it is advisable to include double this amount in the ration, which requires half of one percent of average cod liver oil, containing 100 International units of vitamin D per gram. For optimum egg production and hatchability, about 100 units per hundred grams of ration (mash and scratch grain) or 200 units per hundred grams of laying mash are required. Irradiated ergosterol is an inefficient source of vitamin D for poultry.

Other Vitamins: Vitamin B₁ or B is required to prevent a disease known as Polyneuritis, characterized by loss of appetite, emaciation and convulsions in which the head is characteristically retracted over the back, followed by death. Cereal grains are good sources of this vitamin, so it is never lacking in ordinary

poultry rations unless the ration has been heated at a rather high temperature. A deficiency of vitamin B₄ also results in paralysis, convulsions and death, but such a deficiency does not occur under practical conditions. Vitamin E is concerned in reproduction. Male birds deprived of this vitamin become permanently sterile and hence cannot fertilize the egg. Females with inadequate vitamin E continue to lay eggs but when these eggs are incubated the embryo dies in the early stages of development. Good practical poultry rations contain sufficient vitamin E. In vitamin K deficiency the symptom is hemorrhage and consequent death. The walls of the blood vessels are fragile and the blood does not clot. However, this disease does not occur under practical conditions. The evidence suggests that there may be two factors concerned in the prevention of lesions and ulcerations in the lining of the gizzard wall. Although gizzard lesions and erosions do appear to occur on poultry farms, they need cause no concern at present. They do not appear to interfere with growth or to cause mortality.

DISEASES ASSOCIATED WITH MINERALS

An adequate supply of minerals is necessary in all poultry rations. During the growing period the requirement is high for the formation of tissues, fluids and bone. At maturity egg production necessitates a large supply. The mineral constituents of a ration have important functions in the physiological processes inside the bird's body, in addition to forming the skeleton.

Poultry require a number of minerals but from a practical standpoint only calcium, phosphorus, salt (sodium and chlorine), iodine, manganese and possibly iron and copper need consideration. The other minerals are supplied in sufficient amounts by the ordinary ingredients in poultry rations.

Calcium or Phosphorus Deficiency: Poultry rations consist to a large extent of grains and their products, which are fairly good sources of phosphorus but poor sources of calcium; hence, there is less danger of a phosphorus deficiency in poultry feeding. Calcium is the mineral most likely to be deficient.

Symptoms: The lack of these minerals will result in poor calcification and consequent bone deformities, similar to those encountered in rickets. Egg production is decreased and the egg shells will become thin and are easily broken. The skeleton acts as a reserve for these minerals. For instance, if the ration fed to laying birds is deficient in calcium the hen will withdraw the mineral from her bones to meet the requirement for shell formation. If the deficiency is small, the call on the bones will be slight and during a period of nonproduction the mineral is restored to the bones. If the deficiency is severe, sufficient mineral will be withdrawn to permanently damage the bone structure.

Treatment: The treatment consists in supplying adequate amounts of mineral in the ration. Meat meal, fish meal and dried milk products supply appreciable quantities of calcium and phosphorus. Oyster and other marine shells and limestone furnish calcium, while bone meal and bone char supply both calcium and phosphorus. Chick rations should contain about one percent of calcium and 0.5 percent phosphorus, although some workers prefer to feed up to two percent calcium and one percent phosphorus. The calcium requirement of laying birds will depend upon the size and number of eggs laid. This requirement is commonly met by giving the birds access to hoppers of oyster shell or limestone. In view of the varying amounts of such protein supplements as dried milk, meat meal and fish meal, used in poultry rations it is impossible to recommend any definite amount of calcium or phosphorus supplements to be included in rations. For this and other

reasons, it is advocated that mineral supplements, such as oyster shell or limestone and bone meal, should be placed in separate, accessible hoppers for both chicks and laying birds and allow them to partake of such supplements as they desire, rather than mixing them in the ration.

It should be borne in mind that an adequate supply of vitamin D is necessary in order that the birds may utilize the calcium and phosphorus in the ration. The ratio of calcium to phosphorus in the ration is of some importance. Provided the chick rations contains an adequate supply of vitamin D and reasonable levels of calcium and phosphorus, the Ca/P ratio may vary between 3/1 to 1/1, with 2/1 optimum.

Rock phosphate or phosphatic limestone should never be used as a mineral supplement because they are generally contaminated with fluorine. Fluorine in rather small amounts is not only injurious to bone formation and egg production but may be decidedly toxic. Similarly dolomite limestone should not be used because it is often contaminated with sufficient magnesium to be harmful to bone formation.

Salt Deficiency: Feeds of plant origin, such as cereal grains and vegetable protein supplements like soyabean oil meal, have a low content of sodium and chlorine (common salt). Animal protein supplements, such as meat meal, fish meal and milk, contain appreciable amounts. However, it would seem to be a safeguard to add salt to poultry rations, since there is some variation in the salt content of animal products.

Symptoms: A deficiency of salt results in poor growth and inefficient utilization of foods. Laying birds lacking salt show decreased egg production and egg size. Cannibalism may result, but this is by no means the only cause of cannibalism. Excessive amounts of salt are quite toxic.

Treatment: Poultry rations should contain from one-half to one percent of common salt.

Iodine Deficiency, Goitre: Iodine is necessary for the proper functioning of the thyroid gland, which consists of two lobes at the base of the neck, one on each side. If iodine is lacking in the ration, the gland increases in size and goitre results. Goitre is rarely, if ever, encountered in Ontario poultry. Iodine comes from the sea, and the water, soil and crops of inland regions are deficient in this mineral. Marine products, such as fish meal, oyster shell and fish oils, which are common ingredients in poultry rations, all contain iodine. However, the use of one-half to one percent of iodized salt (ordinary salt to which potassium iodide has been added) in poultry rations is a safety measure. There is no evidence that the feeding of additional iodine to the amount ordinarily present in poultry rations, is beneficial.

Iron and Copper Deficiency, Anaemia: Iron is necessary for the formation of hemoglobin, the red coloured material in blood. If the ration is deficient in iron, nutritional anaemia, characterized by a deficiency of hemoglobin in the blood, results. A trace of copper is necessary for the utilization of iron. Nutritional anaemia would appear to be of little practical importance since ordinary poultry rations seem to supply sufficient iron and copper. Even those workers who consider that heavy egg production may lead to anaemia, are not unanimous that feeding extra iron and copper will prevent the disease. Anaemia is also a symptom accompanying certain specific diseases. Such anaemia is not the result of a deficiency of iron in the ration.

Perosis: Slipped Tendons, Hock Disease, Deforming Leg Weakness and Manganese Deficiency: Perosis or slipped tendons, sometimes called deforming leg weakness or hock disease, is concerned with mineral metabolism. In the normal chick the tendons slide in a groove at the back of the hock joint (tibia-metatarsal joint). In chicks suffering from this disease, these tendons, particularly the Achilles tendon, slip out of this groove to one side or the other, and hence pull the leg bones out of line, resulting in more or less deformed legs, depending upon the severity of the disease. One or both legs may be affected. Usually there is an enlargement and flattening, and sometimes a twisting, of the hock joint or of the entire shank. In some instances all the symptoms are evident but the tendons do not slip from their normal position. Since the legs become bowed and badly deformed, perosis is often confused with rickets, although the abnormality has no relation to vitamin D. In perosis the bones are hard and well calcified, while in rickets the bones are soft and poorly calcified.



Fig. 9.—Perosis. The tendons have slipped on the right leg, drawing it out of shape. (After Norris, Cornell)

Chickens of the heavier breeds are more susceptible than those of the light breeds and the disease is more common in the more rapidly growing chicks. Battery brooding, or the use of wire floors, seems to aggravate the condition. Perosis is associated with excessive amounts of calcium or phosphorus, particularly the latter, in the ration. This is commonly brought about by the inclusion of disastrous amounts of such mineral supplements as bone meal in rations which already contained a large amount of these minerals supplied by meat meal and fish meal. Large amounts of corn in the ration will also result in perosis. Wheat germ, wheat bran, wheat middlings, oats, oat feed (hulls, shorts and germ), oat dust (shorts and germ) and oat hulls are protective feeds. Recently it has been shown that perosis is caused by a deficiency of manganese in the ration and that the

perosis-preventing properties of feeds are associated with their manganese content. However, it appears that this mineral is not the only factor concerned.

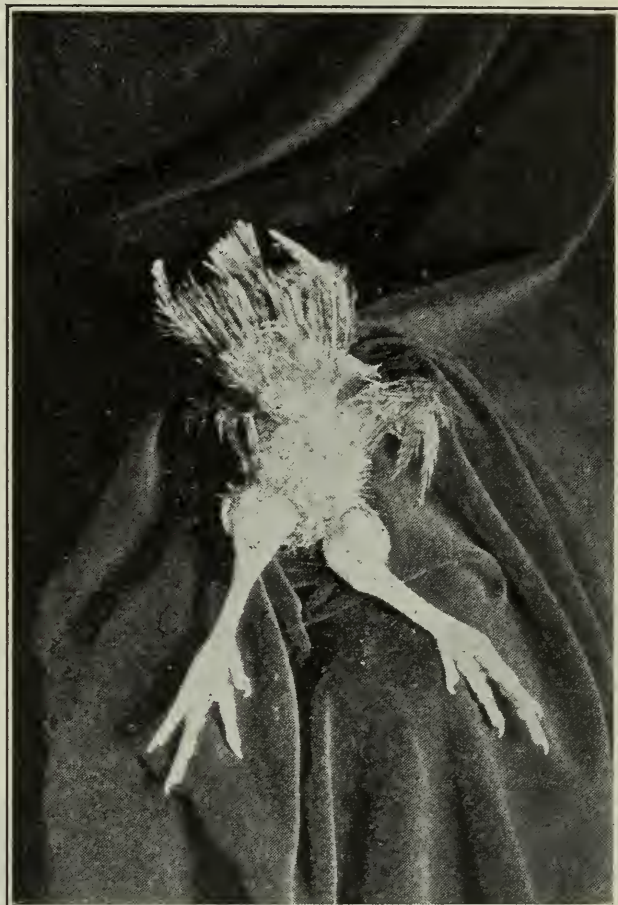
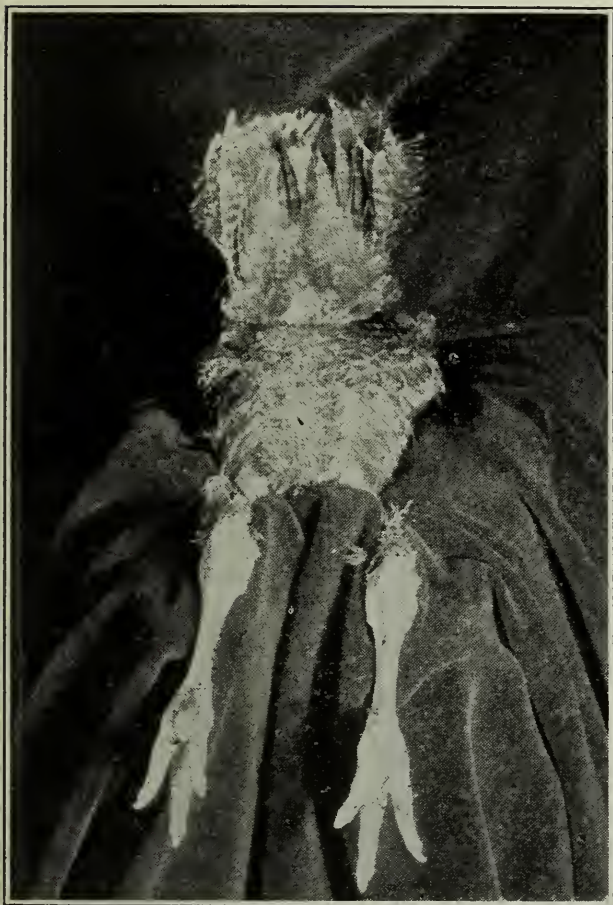


Fig. 10.—Perosis. The bird on the left is normal. The bird on the right is suffering from perosis or slipped tendons in both legs. Note the enlarged hocks. (Original)

Manganese is also necessary for growth, egg production and hatchability. Poultry seem to require about fifty parts per million (0.005 percent) of manganese in the ration. Excessive amounts are harmful but the toxic level appears to be between two thousand and five thousand parts per million. Perosis has never been a particularly serious problem in Ontario; even in those flocks where it has been encountered the percentage of the birds afflicted has usually been small. These facts would suggest that manganese is not particularly deficient in Ontario rations.

Treatment: There is no known cure for perosis. The only means of control lies in prevention. Excessive amounts of calcium and phosphorus should not be fed in a ration. The provision of such mineral supplements in separate, accessible hoppers is a safeguard in this connection. The ration should contain some of the protective feeds, such as wheat or oat products. If perosis has occurred in birds fed on a particular ration, under a particular set of conditions, or if the poultryman wishes to add manganese to his rations, a reasonably safe practise is the addition of one-quarter of a pound of a technical grade of manganese sulphate to a ton of feed.

DISEASES ASSOCIATED WITH THE RATION

Certain diseases seem to be associated with the ration fed to the birds, although the ration is probably not the only factor involved.

Gout: Gout is characterized by the deposition of urates in the internal organs or joints. It may be produced as a result of the ration or by disease of the kidneys or ureters. It appears to be almost entirely a disease of adult fowl. The disease appears to occur often as a result of high protein feeding. Confinement and lack of exercise are predisposing factors. The internal symptoms are also characteristic of vitamin A deficiency, so this may also be another cause.

Symptoms: The condition may appear in two forms, visceral gout, affecting the internal organs only, and, rarely, articular gout, in which the joints are involved. In visceral gout there is no characteristic external symptom by which the disease can be recognized. When the internal organs only are affected the comb and wattles are pale and the bird is droopy, weak and emaciated. In the articular form the joints and legs become swollen and painful. Occasionally the swellings may break and discharge a yellowish-grey material.

In visceral gout, post-mortem examination reveals the organs and serous membranes, lining the body cavities and organs, covered with a white, powdery deposit of sodium urate crystals. The kidneys are enlarged and spotted with this deposit. The ureters are enlarged and plugged with the same material. In the articular form the swellings contain chalk-like deposits up to the size of a cherry and similar masses may be found in the adjoining bone marrow, tendons and blood vessels, or under the skin.

Treatment: The usually recommended treatment is to give all birds a dose of epsom salts, if a number of birds in the flock develop gout. The protein in the ration should be reduced and the birds supplied with plenty of green feed. Water consumption should be encouraged.



Fig. 11.—Necrosis of the beak in the early stages. The fine pasty feed is accumulating on the beak. If this feed is cleaned from the beak and a more granulated mash is fed, the condition usually can be corrected at this stage. (Original)

Necrosis of the Beak: This condition is usually the result of feeding a finely ground mash or one that is pasty when moistened. The finely ground feed packs under the tongue and sticks to the edges of the upper and lower mandibles (the beak). Inflammation and consequent rotting away of the tissues follow, which may result in the loss of the lower mandible, and, in severe cases, the upper mandible as well. The condition can be cured in its earlier stages by removing the impacted food material and changing from a finely ground to a more coarse or granular ration.



Figure 12.—Necrosis of the beak. The bird on the left shows the inflammation and rotting away of the beak. The lower mandible of the bird on the right has rotted off and the tissue is healed over. (Original)

Impaction of the Crop, Crop-bound: Impaction of the crop may be due to loss of tone in the muscular walls from some disease or from over distention with dry grain, or excessive accumulation of fibrous material in the crop. Mechanical stoppage of the opening out of the crop by feathers, fibrous material or foreign objects, may occur. Many cases in a flock point to some error in feeding or management.

Symptoms: Loss of appetite and difficulty in swallowing are evidenced. The crop is distended and pendulous and, on handling, it may be found to be quite firm or it may be distended with a vile smelling fluid. The bird may die from exhaustion.

Treatment: If the impaction is not too severe, a little oil may be given and the crop massaged to mix the oil among the contents. Then, holding the bird upside down, try to work the material back through the gullet or, by manipulation, to remove the plug. In the case of fibrous material the crop must be opened, the contents removed, the crop washed out and sewed up. An incision about an inch in length is usually sufficient and is made with a sharp knife, after plucking out a few feathers and painting with tincture of iodine. Insert a finger to make sure that all material has been removed. The incision should be closed with three or four stitches in the crop wall and also in the skin. These sutures should be interrupted, that is, made and tied separately. Fast the bird for a day or two and then give soft food, such as bread and milk, for a few days.

Feeding a ration containing too much indigestible fibrous material, or feeding a poorly balanced ration, or underfeeding, is a predisposing factor. Under these latter conditions the birds are liable to eat the litter, which may cause impaction. It is almost impossible to set any limit for the amount of fibre in poultry rations, although poultry do not digest fibre particularly well. However, there appears to be quite a variation in their ability to handle fibre from different sources. Occasionally there is a tendency for the gizzard to become impacted, especially in chicks, with fibre. Feeding an insoluble grit, such as granite, quartz, feldspar, mica or washed gravel, aids in preventing this condition.

Cannibalism, Feather Pulling, Toe Picking, etc.: These vices may often become serious. Toe picking is the more common occurrence in baby chicks. Growing chickens and laying birds often confine themselves to feather pulling, but one can never be sure as to whether feather pulling may develop into cannibalism, particularly if this feather pulling draws blood. Cloaca or vent picking, commonly known as 'pickouts', is a common manifestation of cannibalism in laying birds. Egg-bound conditions and prolapsus are often an inciting cause.

It is extremely difficult to decide the exact cause of cannibalism. Faulty or deficient rations may be a contributory cause. Faulty management such as overcrowding, lack of ample hopper space, or in the case of chicks failure to maintain a moderate, even temperature in the brooder may also result in cannibalism. Some strains or breeds of poultry are much more prone to cannibalism than others. It may be started by one or two birds and the others follow their lead, until the habit is widespread.

In the case of chicks the vice should be guarded against by proper feeding and management. The chicks should have plenty of floor and hopper space and, in so far as possible, strong beams of light should be prevented from reaching certain parts of the floor. Painting the windows with a red paint, or using ruby light bulbs, has been recommended. Painting the injured parts of the chicks with 'anti-pick' ointments, which are unpalatable, also aids. With growing chickens or mature birds some measure of success has followed the placing of hoppers of crushed oats before the birds. Once the vice is firmly established in laying birds it is almost impossible to control except by mechanical devices such as vent shields which protect the birds on which they are placed, or by guards or 'spectacles' fastened to the beak in such a way that the bird can eat its food but cannot pick another bird. Cutting back the tip of the upper beak to a point where it is painful for that bird to attack another is a temporary means of control. It has been well said that poultry are somewhat like children and the provision of ample opportunity to keep busy at harmless little activities keeps them out of mischief. Cannibalism in certain instances appears to be the result of mischief since there is nothing else to occupy the attention of the birds. Removal of wounded birds also aids in control.

Egg Eating: This habit may commence through the accidental breaking of an egg, so care should be taken to prevent this by the use of suitable nesting material and the provision of ample nests so that there is no danger of overcrowding in the nests. If this habit of egg eating becomes established it is difficult to check. Nest boxes constructed to allow the egg to roll out of reach, darkened nests, filling shells with some hot mixture such as red pepper and mustard, are methods used to combat this vice.

Rations deficient in calcium, or vitamin D, may be the cause. The craving for the calcium in the shell causes the bird to eat the egg. This can be prevented by the provision of oyster shell or limestone and bone meal, and the inclusion of

ample vitamin D, furnished by cod liver or other fish oils, in the rations. When the ration is lacking in calcium or vitamin D the egg shells tend to become thin and hence are more easily broken. However, outbreaks of egg eating do occur when an ample supply of these nutrients is apparently available.

BACTERIAL DISEASES

PULLORUM DISEASE

By far the most important disease with which the poultryman has to contend is pullorum disease. In chicks the condition was formerly termed bacillary white diarrhoea, and it is responsible for more chick losses than any other disease. The infection is also the cause of sickness and death in adult fowl. Turkey poult may also contract the disease.

Cause: Pullorum disease of chicks is an acute, highly fatal disease, caused by a germ, *Salmonella pullorum*. It is very contagious and the mortality rate in some outbreaks is high.

Sources of Infection: The greatest number of cases result from infected eggs. As a rule, in an outbreak among chicks, some of the affected birds survive and apparently entirely recover. These birds harbour the causative organism in the ovary where it may produce disease in that organ and destroy its function. Usually, however, the disease of the ovary is not sufficiently extensive to prevent the production of eggs. Many eggs laid by such birds are infected with the germ although they appear normal. These eggs are capable of being fertilized, and when used for hatching purposes the newly formed chicks become infected and either die in the shell or become sick with the disease at the time of hatching. Other sources of infection among chicks and poults are contaminated incubators and brooders, and food, drinking water and utensils soiled by the droppings of infected birds. In adults the disease is chiefly spread by eating infected eggs. The disease is most prevalent in chicks from two to fourteen days old, although some losses may occur up to three and occasionally four weeks after hatching. Usually the heaviest losses are among chicks that have been shipped some distances, due in many instances to their vitality being lowered by chilling. (If only a day or two old at this time these chicks would obviously be infected before being shipped.)

Symptoms: The affected chicks are drowsy, listless, ruffled and droopy. Appetite is diminished, and the birds remain sitting or standing in the same position. In cases where the lungs are infected gasping for breath is a common symptom. Loss of flesh is frequently observed. Diarrhoea is often present, although this is not a diagnostic symptom as it is also caused by other conditions. When present in this disease it is whitish, creamy and sticky, and sometimes contains brownish streaks. The passage of droppings is quite often accompanied by pain, evidenced by a sharp cry of distress. The sticky droppings adhere to the down, and may collect to such an extent that the vent is plugged. The chick then has the appearance of being "short backed" or "big bellied", and death soon results. In practically all fatal cases the chicks become progressively weaker, breathing becomes difficult, and they sit or lie with outstretched wings until they die. When the infection is confined to the ovary in adult birds no symptoms of disease are, as a rule, observed. If other internal organs become infected the birds may cease to lay and become thin and weak. Deaths due to this infection frequently occur, but usually at fairly long intervals. It is very uncommon to find several birds in a flock dying at the same time from adult pullorum infection.

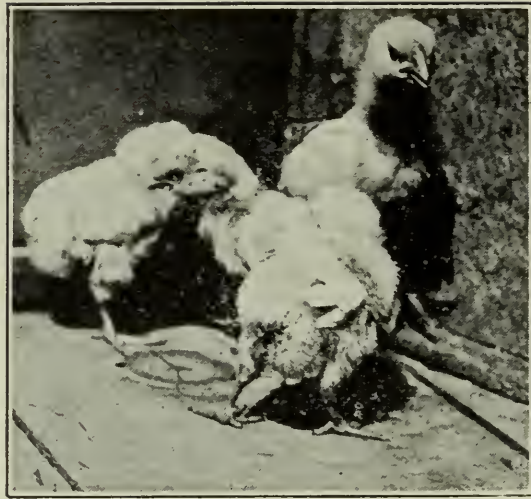


Fig. 13.—Pullorum disease in chicks. (Poultry Dept., O.A.C.)

Post-Mortem Appearances: Quite often there is little to be seen in chicks that have died from this disease that is of assistance in arriving at the cause of the trouble. In some cases the internal organs are pale, and the general loss of flesh is quite marked. The intestines may be partially filled with a sticky, stringy fluid. Changes in the liver occur sometimes, but it is usually difficult to recognize these as the normal change in colour of the chick's liver from yellow to reddish brown is gradual resulting in a mottled appearance. Nodules in the lung are almost always the result of infection with the germ of pullorum disease. Although an unabsorbed yolk is common to all chicks only a few days old, it is characteristic of the disease in birds that are over a week old. In adults the ovary shows decided change. The infected ova may be hard, shrunken and angular, and dark brown or greenish in colour. Quite frequently masses of yolk material are found loose

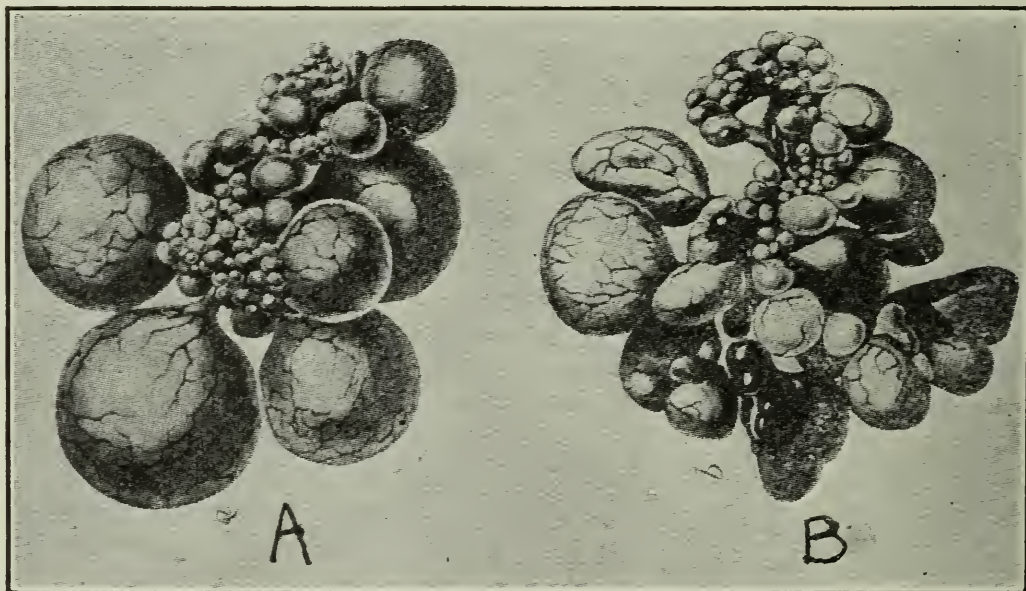


Fig. 14.—(a) Normal ovary of fowl; (b) Ovary infected with "*Salmonella pullorum*". (After Rettger)

in the body cavity or in the oviduct. The heart may be enlarged and covered with grayish nodules or with a whitish cheesy material. If the lungs are affected they usually present a grayish appearance.

Diagnosis: Whilst a knowledge of the symptoms and post-mortem appearances are of value the only reliable means of diagnosing the disease in chicks is to find the causative organism. This can be done only in a laboratory equipped for the purpose, and when the disease is suspected several chicks should be sent to such a laboratory for a bacteriological examination. Infected adults can usually be detected by means of a blood test or by what is known as the wattle test. A number of veterinarians in Ontario conduct blood tests for the detection of pullorum infected birds, and their names and addresses can be obtained on application to the Central Experimental Farm, Ottawa. The wattle test is not used very much here as it has not proved so reliable as the blood test.

Treatment: In spite of extravagant claims made by some that certain medicinal agents are of value in the treatment of this disease nothing that has been tried is of value. Potassium permanganate in the drinking water may help stop the spread of the disease through the medium of the water. Enough should be added to the water to give it a deep red colour. Buttermilk has also been suggested as being helpful.

Control: All birds (both male and female) in the flock over four months of age should be blood-tested just before the hatching season, and all positive reactors should be promptly removed from the premises. Eggs purchased for hatching should be obtained from pullorum disease-free flocks. Chicks and adults should likewise be purchased only from such flocks. Custom hatching should not be done. Raw eggs should not be fed to the birds. Birds returning from exhibitions or egg-laying contests should be quarantined and blood-tested before being added to the rest of the flock. The incubators should be frequently fumigated, and incubator waste should be properly disposed of by burning. Hygienic conditions around the premises, particularly the quarters used for rearing chicks, must be maintained.

AVIAN TUBERCULOSIS

(Tuberculosis of Fowl. Going Light)

Avian tuberculosis is a chronic infectious disease, and is found in most localities where fowl are raised. It occurs principally in chicken flocks on account of the closer contact and greater opportunity for spread among these birds. Turkeys, geese, ducks, swan, pheasants, pigeons and other wild birds are also susceptible to the disease.

Cause: A germ, *Mycobacterium avium*, which is very resistant, and may remain alive outside the body of the fowl for a long time. It will survive for several months in rigorous winter weather.

Transmission: The fecal material of infected birds contains large numbers of the organisms, and this constitutes the principle means of spread of the disease. Feed and water become contaminated, and if ingested by other fowl results in infection. Wild birds, rats and mice may introduce the disease, and quite often the disease is brought into a healthy flock by the addition of a diseased fowl. It can also be mechanically transmitted by persons handling tuberculous birds or on feed sacks. Eggs from diseased birds may contain the germ, and if fed, as in the case of infertile incubator eggs, may spread the disease. Trimmings and offal from infected carcasses, when carelessly disposed of, have resulted in its introduction into a flock. Undoubtedly, the infection usually takes place by way of the digestive tract. Although perhaps not of common occurrence birds may contract the disease from tuberculous cattle and swine.

Symptoms: The disease is slow in developing, and symptoms are principally noticed in birds over a year old. Although the birds may be good feeders they become thin and wasted. This is particularly noticed in the breast muscles. The comb and wattles are pale and sometimes yellowish. Swelling of the legs and lameness are common, due to joint infection. These swellings may burst and discharge a cheesy matter. (Swelling of the joints in pigeons and parrots is apparently most often associated with tuberculosis.) The feathers are ruffled, wings droop, and the bird is listless. In the later stages diarrhoea is present. Death may occur among members of the flock at fairly long intervals, and the presence of the disease may not be suspected. Occasionally a bird may die while still fat and in apparently good condition due to hemorrhage from the liver, that organ becoming softened as the result of degenerative changes.

Post-Mortem Appearances: As the alimentary tract is the most common means of entry of the causative organism, abdominal tuberculosis is the form most commonly observed in fowl. The liver and spleen are most often affected. The intestines and mesentery (membrane supporting the intestines) are also common locations of the nodules. Infection of the lungs is not often seen, although lesions are occasionally found there, as well as in the kidneys, gizzard, peritoneum, ovary, testicles, heart, skin, joints and bones. The liver is usually enlarged and softened. Greyish, yellowish or yellowish-white nodules are found. They may be few in number and quite small in size. In more advanced cases the liver is thickly studded with enormous numbers of them on the surface and in the liver substance. The nodules vary in size, and have a capsule of fibrous tissue. When cut into they may be gelatinous, dry and crumbly, cheesy or occasionally gritty, depending largely upon their age. The spleen may or may not be enlarged, and is quite often not of normal shape. The nodules may be scattered through the splenic



Fig. 15.—Tuberculosis of liver and intestines. (After D. H. Jones)



Fig. 16. — Tuberculosis, showing emaciated condition of carcase. (After D. H. Jones)

tissue or may appear through the distended capsule. When the intestines are affected large or small nodules may be seen in or on them similar to those in the liver. The same may be seen in the mesentery. Occasionally large, cheesy, yellowish-white areas are found in the lung. Diseased joints contain a yellowish, cheesy or crumbly material. Nodules may be found in any of the organs.

Differential Diagnosis: As a general rule, if one is familiar with the disease, a post-mortem examination is all that is necessary in making a diagnosis. At other times a microscopical examination has to be made. The disease may be confused by some with enterohepatitis, neurolymphomatosis, tumours, gout, tape-worm infestation or joint infection due to fowl cholera. However, a poultry pathologist, as stated above, can usually readily make his diagnosis from the post-mortem findings alone. The tuberculin test is employed to determine the extent of the disease in a flock. If skilfully applied it is quite reliable. It should only be conducted by a qualified veterinarian.

Prevention and Control: Nothing can be done in the way of treatment. If the disease exists in a large or valuable flock the tuberculin test (using avian tuberculin) should be applied, and all birds showing a positive or doubtful reaction should be destroyed, and the remainder of the flock removed to fresh clean quarters. New stock should be tested before being added to the flock unless it is known that they come from premises where the disease does not exist. Diseased organs, carcasses of affected birds and waste resulting from the dressing of fowl of unknown origin should be burned. Weed out suspicious cases. Keep young stock separated from older birds and dispose of all birds over a year old for a few years. All animals or birds that might serve as carriers of the disease should, as far as possible, be kept out of the houses and runs. If the flock is small the wisest plan is to slaughter all the birds and market those that are not affected with disease, burning the carcasses of the others. Thoroughly clean and disinfect yards, houses, runs, utensils, etc., and do not restock for at least a year. Swine are quite susceptible to fowl tuberculosis, and although cattle are more resistant, cases have been recorded where a previously clean herd has had several positive reactors to the tuberculin test following their association with tuberculous birds. It is therefore obvious that cattle and swine should not be allowed near fowl with tuberculosis or the carcasses of affected birds. Although the number of infected eggs laid by tuberculous fowl is very small, it would be wise not to use eggs from these birds for human or animal food.

FOWL CHOLERA

(Avian Hemorrhagic Septicaemia)

Fowl cholera is a highly infectious disease, which is quite often acute, but is sometimes sub-acute or chronic. Many outbreaks occur when birds are overcrowded in poorly ventilated, dirty quarters. It may occur also under excellent sanitary conditions. It is characterized in typical outbreaks by sudden death and a high mortality rate.

Cause: A germ, *Pasteurella avicida*. It is not a very resistant organism and is quite readily destroyed by the disinfectants ordinarily used. When incorporated in soil or manure, however, it may live for as long as three months. It may be present in the nasal chambers of birds that show no symptoms of the disease. Many strains of the germ have been studied. Some of them are capable of producing a severe form of the disease, whilst others are much less virulent.

Occurrence: Fowl cholera is widespread over the world, and is very prevalent in some localities. It is quite common in Ontario, although some years very few serious outbreaks occur. Apparently it is more frequently encountered in the northern part of this continent than in the southern regions.

Susceptibility: The disease is highly infectious for chicken, geese, ducks, turkeys, pigeons, pheasants and other wild birds. In geese the disease often assumes a virulent character, and is commonly referred to as "goose septicaemia". The domestic mammals are, as a rule, resistant to the fowl type of the organism, although rabbits succumb rapidly to inoculation if the organism is virulent.

Transmission: It is quite often impossible to determine the manner in which the disease is introduced into a flock. Wild birds, such as sparrows and pigeons, quite likely often disseminate the disease by flying from an infected flock to a healthy one. Several outbreaks that have occurred in Ontario point to this as a frequent means of spread. Apparently healthy fowl may carry the infection, and if such birds are added to a susceptible flock an explosive outbreak of fowl cholera often results. Sick birds introduced into a flock will spread the disease, as the droppings of affected birds contain enormous numbers of the germs which are picked up by the others while eating and drinking. Flies and other insects have been shown to be capable of spreading the infection, and it may be brought in to the premises on boots, clothing and utensils. The germs enter the body, as a rule, by the digestive or respiratory tracts. Water fowl contract the disease principally from contaminated water in which they swim.

Symptoms: If the disease is very acute the first indication of infection is the finding of birds dead under the roost or on the nest. Extremely fat fowl are particularly susceptible to this peracute form of cholera. In the less acute type a greenish or yellowish diarrhoea is often the first symptom observed. Birds lose their appetite, but thirst is increased. As the disease progresses the birds become listless and sleepy, dislike to move, and the feathers are ruffled. Respiration is

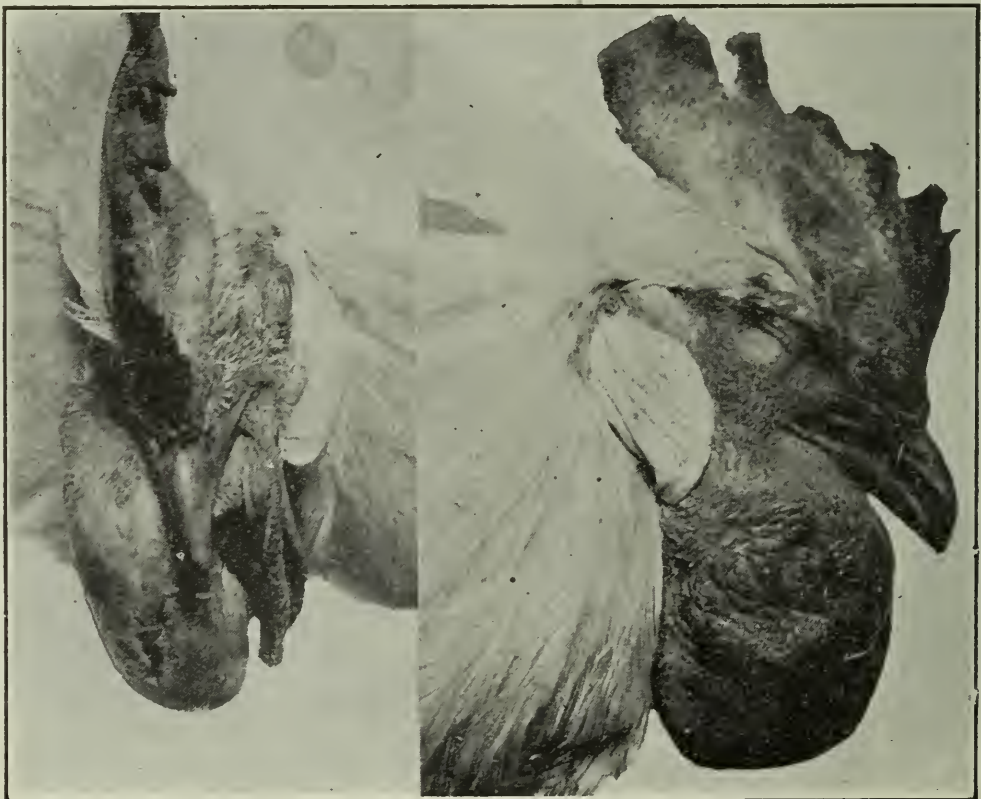


Fig. 17.—Front and side views of infected wattle. (After Gwatkin)

rapid, and the accumulation of mucus in the upper air passages causes a rattling noise as the bird breathes. The body temperature is increased, and the comb and wattles sometimes become purplish in colour. Oedema or swelling of the wattles, especially amongst cockerels, is common. Abrasions are more frequently present in the wattles of cockerels, affording an entrance for the organism. As the outbreak diminishes in virulence the fowl die less suddenly. Chronically affected fowl gradually become emaciated, appear depressed, and the comb, wattles and membranes of the head are pale. Birds suffering from this form of the disease may linger for several weeks before succumbing. Lameness is occasionally seen in prolonged cases, due to the localization of the organisms in the joints resulting in an abscess. Wryneck (neck drawn to one side or backwards) is frequently observed in some birds in a cholera infected flock as the result of brain infection.

Post-Mortem Appearances: In fowls dead of the acute form of the disease the comb and wattles are dark in colour, and there may be a sticky mucus in the mouth and nasal passages. Reddish discolouration of the skin and the breast muscles is a common but not constant finding. The heart shows the most constant changes, having small or large red spots or hemorrhages on its surface. The heart sac frequently contains an excess of yellowish fluid. The first portion of the small intestine usually shows pin point hemorrhages on the inside. Sometimes practically all of the intestine is inflamed with the contents tinged with blood. In some cases the liver is enlarged and studded with small whitish spots. The spleen and kidneys are sometimes slightly enlarged. The lungs are frequently found to be congested or they may be pneumonic. Liquid containing yellowish flakes may be found in the body cavities. In the chronic form of the disease swollen joints are observed containing a dry cheesy substance, and the same material may be found in other parts of the body. In ducks and geese that have died from this disease the heart shows well marked hemorrhages and the lungs are pneumonic and often contain necrotic areas.

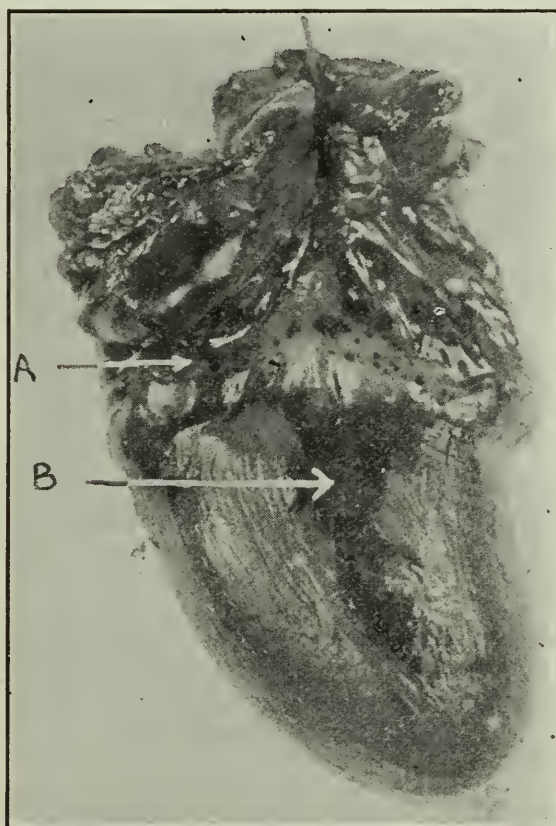


Fig. 18.—Duck's heart showing hemorrhages due to Cholera. (a) Band of small hemorrhagic spots. (b) A large hemorrhagic area.

Control: No medicinal treatment that has been tried has proved of value. Vaccination of a flock with cholera bacterin does not protect in many cases. Some veterinarians claim good results from the use of anti-hemorrhagic serum that is prepared for the prevention of the disease in all animals. Control measures must be vigorous. Split the flock up into small groups, or move the apparently healthy birds to new quarters. Kill the visibly affected birds and burn the carcasses. (As the blood of cholera infected birds is teeming with the germs of the disease care must be taken in the killing to prevent the spilling of blood.) Thoroughly clean and disinfect the houses, runs, utensils, etc., frequently, using fine litter that can be removed quite often. Prevent the birds pecking in the droppings. Keep out wild birds, rats and mice as far as possible. Reduce the concentrates in the ration at least fifty percent. A quarantine period of three weeks for new birds to be added to the flock is of the utmost importance in connection with the control of this disease, and the early morning inspection cannot be over emphasized. Wattles that have become permanently thickened should be cut off after the acute symptoms of the disease have subsided. If there is any pus it can be removed and the part treated with an antiseptic. Excessive bleeding is controlled by the application of tincture of iron.

FOWL TYPHOID

(Fowl typhus. Klein's disease)

Fowl typhoid is an infectious septicemic disease usually acute in character. It is widely disseminated on this continent, although no cases have been observed in this laboratory among birds sent in for examination during the past few years. It is apparently more common in warm wet weather.

Cause: The causative organism of fowl typhoid is a germ, *Shigella gallinarum* (*Eberthella sanguinaria*). This organism is similar in some respects to the germ causing pullorum disease. The organism is not very resistant, and is readily destroyed by the common disinfectants as well as by direct sunlight.

Susceptibility: Chicken are most often affected, but the disease has been reported in turkeys, ducks, peafowl, geese, pigeons, guineas and other fowl. Young adult birds appear to be the most susceptible, although the disease has been found in more mature fowl as well as in chicks. The mortality is not usually as high as in outbreaks of fowl cholera.

Transmission: Sick or recently recovered birds introduced into a flock is one of the means by which the disease is spread. Wild birds or other animals may carry the infection from flock to flock, and it can also be brought in on shoes or clothing. Contamination of soil, water and feed from the droppings of infected birds is a common source of spread as the droppings teem with the causative organisms.

Period of Incubation and Duration: The first symptoms usually appear from three to six days after infection, but in some instances do not present themselves for four or five weeks. Recoveries from the disease are rare and death usually takes place within less than two weeks.

Symptoms: Drowsiness and listlessness are often the first symptoms noticed. The head may be held close to the body and hang limp. The feathers are ruffled and the wings droop, and the birds may be too weak to stand. The comb and

wattles, are usually pale, but in some cases, owing to a weakened heart's action, they are darker than normal. There is a profuse greenish diarrhoea. Appetite is diminished, but thirst is increased, and the temperature is raised. The blood is paler in colour than normal.

Post-Mortem Appearances: Emaciation is usually observed on post-mortem, and the carcase appears pale. The blood is pale and watery and does not clot readily. The liver is enlarged, easily broken, and is often bronze coloured. The spleen and kidney are usually enlarged and softened, the former being darker and the latter paler than those found in normal carcasses. As a rule the intestines are pale, and the contents are yellowish and slimy. In some cases greyish nodules are found on the heart, and the ovary may show similar lesions to those found in pullorum disease. A positive diagnosis can only be made by a bacteriological examination.

Control: As treatment of sick birds is not of value, measures should be adopted to prevent the spread of the disease in a flock. These measures are the same as those outlined for controlling cholera. As there is a possibility that some eggs laid by infected birds contain the organism, care should be exercised in the disposal of eggs from an infected flock.

BOTULISM

Botulism in fowls is commonly known as "limberneck", and is characterized by nervous symptoms, great prostration, coma and often high mortality.

Cause: A powerful toxin produced by the *Clostridium botulinum* (*Bacillus botulinus*). Of the three types of the organism — A, B and C, only A and C produce toxins affecting fowl. The organism forms spores, and low wet places favour their survival. Birds affected are chickens, ducks and geese.

The sources of the organism are fly maggots found in carcasses of animals that have died of botulism, spoiled meat, decaying vegetable matter, spoiled food (including canned goods), putrid water, carcasses of decaying fowl.

Occurrence: Outbreaks of botulism have been reported from widespread localities in the U.S.A. It is apparently not common in Ontario. The disease is more prevalent during warm weather because of the favourable conditions for its production.

Symptoms: Usually a number of fowl in a flock are affected, and if seen in the early stages the birds appear dull and listless with no desire to feed. Later a partial paralysis of the neck and wing muscles is seen with the head and wings resting on the ground. The legs become paralyzed and the birds are unable to stand. The affected birds lie outstretched with heads and necks curled under them. The feathers are loose and easily plucked out. If the birds are picked up they make a noise evidencing pain. The temperature is below normal, and if the birds were in good condition when attacked the comb remains red.

Course of the Disease: If only small amounts of the toxin have been ingested only a few of the symptoms (including dullness and leg weakness) are observed, and recovery takes place. Fatal doses of the toxin often result in rapid death or death after several hours lingering in a comatose condition.

Post-Mortem Appearances: Very little is found on a post-mortem examination that is characteristic of the disease. In some cases there is inflammation of the intestines, and if large amounts of the toxin have been taken up by the birds there may be hemorrhages in the brain and a sloughing of the lining of the gizzard. The crop may contain maggots, spoiled grain or pieces of meat, but it should be borne in mind that these may not contain the botulinus toxin. Maggots are present in many materials containing none of the toxin. Diagnosis is usually dependent on finding a number of birds exhibiting the symptoms described and the finding of spoiled foods.

Treatment and Prevention: Remove affected birds to a cool place and give each one a teaspoonful of Epsom salts in water or a teaspoonful of castor oil. Search for possible sources of the toxin — decomposing carcasses, spoiled feed, etc. Burn all such material. Replace suspected feed with known clean feed. To prevent the disease in exposed birds botulinus antitoxin may be used, but it is rather expensive. It is usually not practicable to inoculate the affected birds, as the trouble is not recognized until too late. The unaffected birds should be confined until the source of the trouble is removed, and should be given a dose of Epsom salts in the drinking water at the rate of one half pound to each one hundred birds. Discourage the feeding of spoiled foods.

COLDS AND ROUP

(Catarrh. Coryza)

The disease commonly known as roup is a severe catarrhal inflammation of the mucous membrane of the respiratory tract. It is often a complication of fowl pox, and at one time was considered another form of that disease. Quite frequently, when only one bird is available for examination, and no history accompanies the specimen, it is not easy to distinguish between the two conditions. Roup may spread very rapidly in a flock, and occurs most often in damp cloudy weather. Predisposing factors include faulty feeding, lack of sanitation, dampness, draughts, improper ventilation, overcrowding, internal and external parasites, inclement weather, sudden changes from range to winter quarters, and outbreaks of contagious diseases. Chicken are most commonly affected, and roup also sometimes causes heavy losses in turkey and pigeon flocks.

Cause: The exact cause of roup is not known. It is doubtful if all outbreaks of roup are due to any one particular germ or virus. It is quite likely that microorganisms which are ordinarily harmless become active under certain conditions and produce the typical symptoms and lesions. One germ has been isolated which apparently always produces the disease when inoculated into susceptible birds.

Symptoms: A watery discharge from one or both nostrils, accompanied by sneezing and shaking of the head, are usually the first symptoms noticed. The discharge soon becomes thick and sticky and has an offensive odour which is characteristic of this disease. It dries in yellowish crusts around the nostrils, and soon the sinuses become filled with mucous owing to the extension of the inflammation. The accumulation of this material in the sinuses under the eyes causes a marked swelling of the face. (As the openings from these sinuses extend from a low level up into the nasal chambers the material is unable to drain away). Owing to the extensive swelling the eyes may become closed, and they may also become involved, and contain a cheesy material. The same kind of material may be found in the mouth and throat, but these patches differ from those found in

fowl pox in that they are not so closely adherent and can be easily removed without damaging the underlying tissue. The affected birds are depressed, feathers are ruffled, appetite is diminished and the head is frequently shaken in an attempt to dislodge the mucus. Breathing is interfered with in many cases. If the disease runs a long course the birds become emaciated.



Fig. 19.—A bad case of roup photographed two days before death. (After Gwatkin)

Post-Mortem Appearances: No lesions, other than those described under symptoms are found on post-mortem, and as a rule the disease is not confused with fowl pox or laryngotracheitis. In fowl pox, as previously mentioned, the patches in the mouth and throat are firmly adherent, and usually some members of the flock will have the typical nodules on the comb and wattles. In tracheitis, the lesions are confined to the upper air passages, the eyes not being affected, and there is an absence of the characteristic roup odour.

Treatment and Prevention: If only a few birds in a flock are affected, treatment is not advisable. It is more economical to take these out of the flock, destroy them and suitably dispose of the carcasses. Badly affected birds do not readily respond to treatment. Treatment during the acute stage (colds), in which the only symptom is a nasal discharge, is quite often of value. The mucus in the nostrils and openings in the roof of the mouth should be cleaned out, and ten per cent argyrol, mercurochrome or tincture of iodine instilled into the places every few days until the discharge discontinues. If it is found advisable to attempt treatment of badly affected individual cases the sinuses may be opened with a sharp knife and the cheesy contents removed. The cavities should then be packed with iodine soaked gauze, or rinsed out with some suitable disinfectant solution.

A dose of Epsom salts should be given in the drinking water of the flock (one half pound for one hundred adult birds). Tonics in the mash are of value. Feed nourishing food.

Prevention and Control: Clean, dry, well ventilated quarters, and proper feeding are important factors in the prevention of roup. Avoid overcrowding of birds. Quarantine new and exhibition birds. Keep out wild fowl as much as

possible. Isolate any sick birds until the cause of the trouble is found. Thoroughly clean and disinfect the premises if it is found to be roup, using a medicated spray. In damp weather, however, it is inadvisable to add more moisture in the form of a spray, and efforts should be made to dry up the house. One-third teaspoonful of potassium permanganate may be added to each gallon of drinking water. Birds that have been in contact with the affected ones may be treated with the argyrol or mercurochrome solution as mentioned above. Watch the birds closely, removing affected ones at the earliest appearance of symptoms.

VIRUS DISEASES

Several important diseases of poultry are caused by viruses. A virus, unlike bacteria or germs, is invisible under the ordinary microscope, and will pass through a filter which would hold back bacteria. The cause of these diseases is, therefore, termed 'an invisible virus', an 'ultra-microscopic virus' or a 'filterable virus'. Virus diseases outlined in this bulletin are fowl pox, fowl pest, laryngotracheitis, neurolymphomatosis and leucosis.

FOWL POX

(Avian Diphtheria. Chicken Pox)

Fowl pox is a highly infectious disease of birds, and occurs in one of two forms or a combination of these two forms. In many outbreaks both types of the disease are present in the same bird.

Cause: An invisible virus, which is present in the lesions and is quite resistant to drying and disinfectants. Although closely related the virus causing the disease in pigeons and the virus of fowl pox differ to a certain extent and it is difficult to produce pox in pigeons by the use of fowl virus. On the other hand turkeys can readily become infected with the virus of fowl pox, although under natural conditions the disease in these birds is rare.

The disease is most prevalent during the fall and winter months, but may occur at any season of the year. Usually the economic loss from unthriftiness in the flock and diminished egg production is much greater than from the mortality of affected birds, although in some outbreaks the percentage of deaths is high.

Susceptibility: Domestic chickens are most often affected, and are highly susceptible to the disease. Turkeys are less susceptible, although natural infections have been reported in them, as well as in ducks, geese, pigeons, pheasants, quail and other birds. Very young chicken are apparently not susceptible in Ontario, but in the Southern United States outbreaks among chicks have been seen. Mammals, including man, are not susceptible to fowl pox.

Symptoms: In the skin or cutaneous form small wart-like nodules appear on the comb, wattles, skin of the head, and occasionally on other parts of the body. These nodules are yellowish at first, and later become dark brown or black. If this type of infection is light the birds may show little or no systemic disturbance. Quite often these nodules are very numerous and touch each other forming large scabby masses. Lesions such as these have been reported on feet of chicks, due, it is presumed, to infection from a contaminated toe punch. In the diphtheritic or mucous membrane form cheesy masses are found on the mucous membrane of the mouth, tongue and larynx. The diphtheritic membranes are firmly adherent, and if forcibly removed leave a raw bleeding surface. Later these

patches become larger and thicker, and may become so extensive as to prevent the bird closing its mouth. Breathing is interfered with if these patches are on or near the larynx. If the eyes are involved there will at first be inflammation and a watery discharge, followed by the formation and accumulation of a cheesy material causing a bulging of the eye. Emaciation results if eating is interfered with.

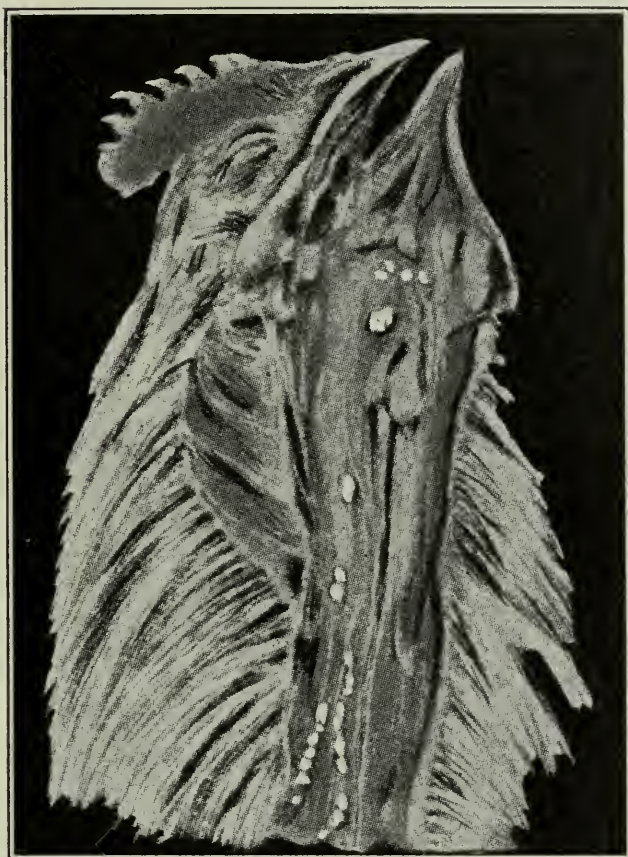


Fig. 20.—Avian diphtheria. Neck slit open to show diphtheritic patches in mouth and oesophagus. (After Ratz)

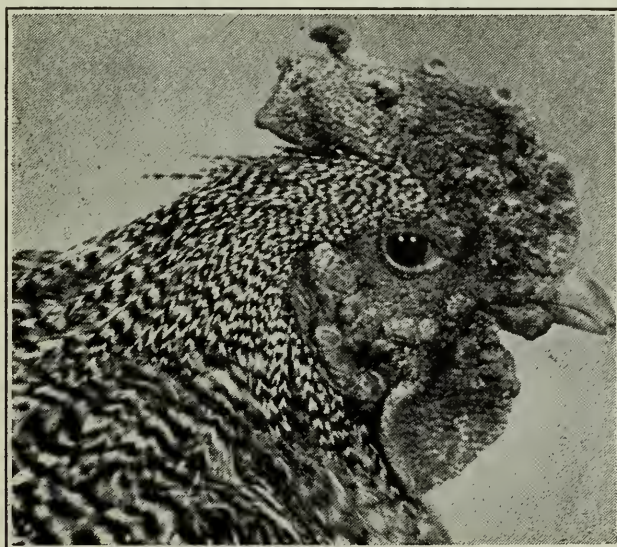


Fig. 21.—Head showing fowl pox scabs.

Incubation Period and Course: According to the virulence of the virus and the manner in which it gained entrance to the body, the incubation period varies from three days to about two weeks. The course varies considerably. In the acute form birds may die in about four days following the introduction of the virus. In other cases the birds may live for two or three months before succumbing. When the attack is mild, and only the skin form is present, recovery may take place in a few weeks.

Post-Mortem Appearances: As a rule no other changes are observed than those mentioned under symptoms. If a post-mortem examination reveals abnormalities in the internal organs it indicates that some other diseased condition is also present.

Transmission: Transmission, as a rule, occurs usually from bird to bird directly, although it has been demonstrated that certain kinds of mosquitoes are capable of transmitting the virus. It may also occur by the ingestion of food or water containing the virus, or by a person handling infected birds, and then carelessly going into another flock.

Treatment: Medicinal treatment is of little value, although the removal of diphtheritic patches which interfere with eating and drinking may be helpful. The raw surfaces resulting from this treatment should be painted with one percent mercurochrome, iodoform, tincture of iodine, ten percent argyrol or five per cent silver nitrate. Very sick birds should be destroyed and their bodies burnt. The other affected birds should be isolated in comfortable dry, well ventilated quarters, and receive the best of food. One half teaspoonful of Epsom salts should be given each bird in the flock twice a week.

Prevention and Control: Fowl that have survived an attack of fowl pox are usually immune to further attacks of the disease. When this fact was established poultry disease investigators conducted inoculation experiments with ground pox scabs suspended in liquid, and eventually proved that fowl could be successfully vaccinated to produce immunity to fowl pox. *At the present time it is not permissible in Canada to use fowl pox vaccine*, so that our attempts to control the disease are largely confined to sanitation and quarantine. Birds returning from exhibitions or laying contests should not be added to the main flock until they have been quarantined for a period of three weeks. Wild birds and other animals should be excluded as far as possible. The houses, etc., should be thoroughly disinfected after sick birds are removed and when the outbreak has subsided.

LARYNGOTRACHEITIS

(Infectious Bronchitis. Infectious Tracheitis)

Laryngotracheitis is a highly infectious disease, and is characterized by its sudden onset, rapid spread, respiratory distress, and often a high rate of mortality. It is observed chiefly during the Fall and Winter months.

Cause: An invisible virus, which is present in the lesions in the respiratory tracts of affected birds. It differs from the virus of fowl pox in that it is usually confined to the respiratory tracts, produces different lesions, attacks only chickens, and has a shorter incubation period. There is a marked difference in the potency of the different strains of the virus.

Transmission: The infection is transmitted fairly directly through the secretions of birds. Fowl that have had the disease, and have apparently recovered,

may introduce the virus if added to the flock. It is quite likely that the virus is sometimes introduced on the clothing of persons who have been in contact with infected birds. Wild birds may also act as mechanical carriers. There is no evidence that the virus is transmitted through the egg.

Susceptibility: Although usually considered a disease of adult fowl, baby chicks are also affected. In these it is quite frequently not diagnosed as laryngotracheitis, but is put down as a cold on account of the watery discharge from the eyes which is usually the only symptom observed. As a rule in young chicks it is not a serious disease, and the mortality is not great. Chicken of all ages may become infected, but it is most common in Ontario in pullets between six and twelve months of age.

Period of Incubation and Duration: The incubation period is fairly short. In experimental cases typical symptoms and lesions have been produced within twenty-four hours after injecting the virus into the trachea of susceptible birds. Natural infection has also been reported as resulting in symptoms of the disease within twenty-four to thirty-six hours after the birds have been exposed, although it would appear that the usual period of incubation is from five to twelve days. The duration of the disease is usually from seven to fifteen days, although symptoms may be observed for as long as a month. Fowls that survive an attack gradually return to apparently normal health, but a few of them become carriers and are capable of introducing the disease into a susceptible flock.

Symptoms: The onset of the disease is sudden and there is a consistent rise in temperature. The first symptoms noticed are a difficulty in breathing and a watery discharge from the eyes. The affected birds have a tendency to remain quiet. A characteristic symptom of this disease is the extending of the neck and opening of the beak while gasping for breath. There is a cough and rattling breathing, and a bloody exudate is often expelled. The appetite is diminished, and the bird presents a rough, unkempt appearance. There may be a watery yellow coloured nasal discharge, which later becomes thick and viscid. The obstruction in the trachea often results in death. In chicks the symptoms observed are a watery discharge from the eyes, rapid respiration, and mouth opened widely on inspiration.



Fig. 22.—Hen affected with laryngotracheitis, showing typical appearance, due to difficult breathing. (After Gallagher)

Post-Mortem Appearances: In a large number of cases the only abnormality noticed is the appearance of small hemorrhages in the larynx. In other cases there is a bloody exudate which extends from the upper larynx. The trachea may be congested. Sometimes yellowish cheesy masses may be found adhering to the larynx, at times almost blocking the opening. A large number of cases observed here contain darkened areas in the lungs.

Treatment: Opinions differ as to the value of treatment in individual cases. Apparently raising the temperature and humidity of the air in the house is beneficial. Instillation into the eyes, nostrils, throat and cleft palate of a ten percent solution of argyrol has been recommended, but it appears doubtful now if this has any value. A medicated water-vapour treatment may give some relief to the affected birds. Nutrition apparently plays a part in recoveries from this disease, and it would seem to be advisable to put the birds on the best of rations and increase the amount of cod liver oil usually given. It has been found that a mash containing some form of milk is beneficial.

Prevention and Control: Efforts should be made to establish a strict quarantine of infected birds, and to isolate for a period of three weeks any fresh birds coming into the flock. Strict sanitary measures such as burning all carcasses, disinfection of runs, houses, utensils, etc., are necessary. Avoid overcrowding of the birds. Plenty of fresh air should be provided, but care must be taken to prevent dampness and draughts. Carefully inspect the entire flock frequently, and immediately remove any sick birds. Utensils used for sick birds should not be used for the rest of the flock, and persons attending the sick birds should have no contact with the others. The change from range feed to concentrated laying rations should be gradual.

Vaccination: This has apparently proved successful in preventing the disease in many parts of the U.S.A. *Its use, however, is at the present time prohibited in Canada.*

FOWL PLAGUE

(Fowl Pest)

Fowl plague is a highly infectious and fatal disease of fowl and is characterized by a very rapid course and high mortality. It affects principally chicken, although turkeys and geese are highly susceptible. Other birds in which the disease has been found include ducks, guinea-fowl, pheasants, owls, hawks and sparrows. Pigeons and wild waterfowl are more resistant to fowl plague. Mammals, including man, are not susceptible.

Occurrence: Fowl plague has been prevalent in various European countries for several years. An outbreak occurred in the eastern United States in 1924-25, and a lesser one in 1929. The occurrence of the disease has not been reported in Canada.

Cause: The disease is produced by an invisible virus, which is present in the blood, liver, nasal and oral secretions, droppings and nervous system of affected birds. It appears to be localized quite largely in the red blood cells. Disinfectants in the strengths ordinarily used destroy it quite readily, but it will live for a long time in the flesh or on the feathers of birds that have died from the disease.

Transmission: As the virus is contained in the discharges from the nose and mouth and the droppings, the feed, water, utensils, etc., contaminated by these are the principle means of transmitting the infection. It can also be introduced into a flock by means of feed bags, crates, cars, litter, and other articles that have been in contact with infected birds. As far as is known external parasites do not transmit the infective agent.

Incubation Period: Is usually from three to five days, although shorter or longer periods have been recorded.

Symptoms: Birds may die without showing any marked symptoms to attract attention. In the less acute type, in which the course is from two to seven days, droopiness and depression are first seen. The wings droop and the feathers are ruffled. The birds stand or lie with eyes closed and are not easily aroused. Breathing is difficult owing to an accumulation of mucus in the nostrils and pharynx. A large amount of frothy mucus may collect in the mouth and drip on the feathers. Diarrhoea is occasionally observed in which case the droppings are tinged with blood. As the disease progresses paralysis of the birds and a staggering gait are seen. The skin in some cases becomes discoloured and the comb and wattles are cyanotic (bluish). Swelling of the comb and wattles may be seen, the swelling sometimes involving the whole head.

Post-Mortem Appearances: Small hemorrhages may be found in the heart, throughout the abdominal organs and fat, on and in the gizzard and proventriculus (digestive stomach), on the under side of the keel bone. (Hemorrhages in the proventriculus and under side of the keel bone are apparently always present, and are therefore of importance in recognizing this disease.) The kidneys are usually swollen and congested, and sometimes the first portion of the intestine shows some inflammation. The swollen areas on the head contain a gelatinous, straw-coloured fluid. The same material is often found under the skin in cases of this disease. The upper air passages and mouth parts contain a large quantity of viscid material.

Prevention and Control: Treatment is not advisable, and as the disease comes under the Animal Contagious Disease Act suspected cases should be reported immediately to the proper authorities. Control measures are vigorous and are strictly enforced on account of the extreme infectiousness of the disease. They include strict quarantine, the killing and burning of sick and exposed birds, the burning of dead birds, offal, and infected feed, litter, etc., and the thorough cleaning and disinfection of premises and equipment.

FOWL PARALYSIS

(Range Paralysis. Neurolymphomatosis gallinarum)

Fowl paralysis is a widespread transmissible disease of chicken which is almost always fatal. Although it is apparently quite common in certain sections on this continent, laboratory and field observations indicate that it is rarely, if ever, encountered here. It occurs chiefly in birds between the ages of three and eighteen months.

Cause: An invisible virus, which is present in the brain, spinal cord and nerves of affected birds.

Symptoms: The outstanding symptom is a partial paralysis affecting the muscles of the leg and wing, and occasionally those of the head and neck. The paralysis is sometimes attended by spasms or tremors. One side is usually more affected than the other. The affected bird usually becomes completely prostrated, lying helpless upon its side with limbs outstretched. During the early stage of the disease the appetite is not impaired. In some cases a grayish yellow discolouration of the iris of the eye is noted, and when the sight is impaired emaciation develops.

Incubation Period and Duration: The incubation period ranges from two to eighteen months. The disease sometimes runs its course rapidly, death occurring within a few days after the first symptoms are observed. Usually, however, the duration of the disease is several months.

Post-Mortem Appearances: The changes observed in the affected nerves consist of swelling and grayish discolouration. Tumour-like masses may be found in the ovary, liver, kidney and intestines.

Transmission: Whilst the mode of transmission is not definitely understood, it appears to be almost always introduced into a flock by the addition of new birds or by means of eggs from infected birds.

Prevention and Control: The treatment of sick birds is not considered practical. Birds that have the disease should be killed and their carcasses burned. The entire flock should be moved to new quarters, or better still should be killed and dressed for market. The premises should be vacated for at least six months after the houses, etc., have been cleaned and disinfected. Systematic annual rotation of poultry runs, supplemented by frequent turning over of the soil is necessary. Strict sanitation and clean soil are important. Eggs for hatching, baby chicks and breeding stock should not be purchased from flocks or premises where the disease has occurred.

LEUCOSIS

(Infectious Leukemia)

Leukemia is a term that has been used rather loosely. The term "leucosis" is therefore now used to cover leukemia and allied conditions, such as pseudo-leukemia in which the blood changes of leukemia are absent. It is apparently closely related to fowl paralysis, and is believed by some to be a form of that disease. The condition as it occurs here has been found only in chicken, and although it is quite common one rarely finds more than one or two birds in a flock similarly affected. If several birds in a flock are affected it would suggest either some common contributory cause or else a predisposition of the particular flock to the disease. Chicken of four or five months of age are more susceptible than older birds.

Cause: An invisible virus which can readily be transmitted by experimental injections of blood and suspensions of organs from infected fowl.

Incubation Period: This apparently varies from one to four months.

Symptoms: The development of the disease is chronic and progressive, and may become firmly established in a flock before it is recognized. Depression, extreme weakness and difficult breathing may be noticed, and the comb and wattles are pale and sometimes have a yellowish tinge. As the disease progresses emaci-

ation occurs, and there is often a greenish diarrhoea. In acute cases death takes place suddenly without any previous symptoms of sickness. Drooping of the abdomen is often observed in chronic cases.

Post-Mortem Appearances: The carcase appears pale and the blood is usually paler than normal and does not clot readily. Enlargement of the liver is a common finding, and this organ may or may not be paler than normal and mottled with gray or white spots. The spleen and kidneys are also usually enlarged and spotted. The bone marrow is grayish red. The intestines are pale, although they may show patches of inflammation.

Transmission: Although the disease in some forms is readily transmissible experimentally, it is apparently not highly infectious under natural conditions. As the virus is present in the blood stream there is a possibility that blood sucking insects play a part in the spread of the infection.

Prevention and Control: Burn carcases of birds that have died from the disease. Cull out unthrifty birds. Strict sanitation should be maintained. If several cases develop in a flock it is better to slaughter all the birds, salvaging the carcases that are not affected. No treatment that has been tried appears to be satisfactory.

PROTOZOAN DISEASES

COCCIDIOSIS

Coccidiosis is a disease of the intestinal tract of birds. It is one of the commonest causes of serious losses in young chicken, and is also found in older birds, but to a much less extent. The disease also attacks turkey poults, pheasants, ducks, geese and other birds. The occurrence of coccidiosis in these birds is not so frequently observed as in chicken, although in turkey poults its prevalence appears to be on the increase.

Cause: The disease is caused by species of coccidia (minute protozoan parasites). Six species of coccidia have been demonstrated in chicken, four of which are capable of inflicting serious damage. The other two species were considered at one time to be practically harmless, but recent observations indicate that at least one of them is quite harmful if the parasites are present in large enough numbers.

The parasite goes through several changes and the resistant stage is known as an oöcyst, which is easily recognized on a microscopical examination. The oöcysts are passed out with the droppings, and at this stage are not infective. They require about two days of warmth, air and moisture for their development, and at the end of this time, if the conditions have been suitable, they are capable of causing the disease if picked up by susceptible fowl. Extreme dryness is destructive to them as are also freezing and high temperatures. Disinfectants, in the strengths usually used, do not kill them.

Symptoms and Post-Mortem Appearances: These depend upon the age of the bird attacked and the species of coccidia present, and are given under the various species. In general young chicken show symptoms similar to those ob-

served in pullorum disease. In older birds, excepting in the case of *E. necatrix* infection, the disease is less acute. Droopiness, diarrhoea and periods of dejection are noticed. The comb and wattles are pale. After from one to three weeks in this condition the bird either dies quite suddenly or apparently recovers. Where re-infestation takes place from time to time the bird becomes progressively weaker and emaciated. Paralysis is a common symptom.



Fig. 23.—Chicks affected with coccidiosis. (After Gwatkin)

Eimeria tenella is found in the ceca of young chicken, and produces that form of coccidiosis which is usually easily recognized by poultrymen. The symptoms produced include those described under pullorum disease, and in addition the droppings are usually blood stained. The ceca, in very acute cases, appear to be dark red or purple in colour, and are filled or distended with liquid or slightly coagulated blood. In older cases the ceca contain a cheesy yellowish core, sometimes tinged with blood. Birds from one month to three months old are attacked by this species, although it has been found in birds as young as two weeks. Chicken under two months of age seldom survive a severe attack, dying in a few days after the first symptoms are noticed. Those that recover are usually stunted.

The upper part of the small intestine is usually invaded by another species, *Eimeria acervulina*, which produces whitish or grayish spots in the wall. A more or less chronic form of coccidiosis is produced, resulting in extreme emaciation of the birds in severe cases.

Eimeria maxima produces a thickening of the wall in the middle or lower part of the small intestine, accompanied by a variable amount of hemorrhage. Diminished appetite, pallor, and ruffled plumage are the principle symptoms. Less blood is passed in the droppings than in the disease produced by the organism inhabiting the ceca.

Eimeria necatrix produces a severe and extensive inflammation of the intestine in older chicken. The most seriously damaged part is, as a rule, the central portion, although one frequently encounters cases in which the whole length of the intestine is involved. Rounded, opaque, whitish spots may be seen on the outside and inside of the gut, which is bluish and easily ruptured. The lining membrane is thickened and roughened, and in severe cases there is a sloughing resulting in a bloody mass all through the intestine. Symptoms are produced five days after infection. The affected birds take a considerable amount of water resulting in distension of the crop. In very acute attacks the combs turn dark.

Eimeria mitis and *Eimeria praecox* apparently do not produce many changes unless the parasites are present in enormous numbers. There is increased mucus in the intestinal tract, and occasionally fine whitish spots in the wall of the gut.

A positive diagnosis of coccidiosis is not given until the parasites are found upon a microscopical examination of the contents of the small intestine or ceca. Quite often the history, the symptoms exhibited, and the lesions found on post-

mortem examination are sufficiently clear to warrant a diagnosis being made, but we have made it a rule not to report the case or cases as coccidiosis until we have demonstrated the causative organisms.

Transmission: Coccidiosis is transmitted by means of feed, water and soil that have become contaminated with the droppings of infected birds. The organisms may be carried for considerable distances in running water or in dust, shoes of attendants, grain sacks, birds, flies or other insects. The infection may also be brought in by rats and mice. It has never been demonstrated that the organism may be included in the egg at the time it is formed, and although the egg shell could be contaminated on its way out of the vent, conclusive evidence that this is a means of spread of the disease is lacking. In an outbreak of coccidiosis the oöcysts are most numerous under perches, brooding canopies, in and around drinking fountains, and around food hoppers. The greatest factor in the spread of the disease is the adult bird that has recovered from an attack running with the younger birds. These recovered adults may harbour the parasites in large numbers in the intestines.

Treatment: As in the case of various other diseases of poultry numerous remedies have been tried and extravagant claims made as to their value. It is now generally agreed that drugs are of little or no use in combatting coccidiosis. According to several investigators a milk flush is beneficial. This is given in the form of powdered skim milk (40 percent in the mash) or milk sugar (20 percent in the mash). It is fed for one, two or three days, discontinued for the same time, and then fed for another one, two or three days. Very little scratch grain should be given during this treatment. Another method is to feed the milk mash for two hours, starve for two hours, feed again for two hours, keeping this plan up for several days. A tonic is indicated later to induce the birds to consume large quantities of feed.

Prevention and Control: In spite of what has been said about treatment, strict sanitation is the only effectual means of control. Under ordinary conditions the oöcysts require about two to four days to develop to the infectious stage. Thus it is of the utmost importance to clean the house, feed troughs and water troughs at least every two days. The feed and water troughs should be kept on wire mesh platforms to prevent the birds pecking in the droppings. Under no circumstances should feed be thrown in the litter. The litter must be kept as dry as possible. Where it is not practicable to change the litter every two days the "deep litter" system should be adopted. After thoroughly cleaning and disinfecting the house, about four inches of shavings, peat, oat hulls, or other fine litter is placed on the floor. This litter is stirred daily with a pitch-fork. Brood the chicks on clean ground, or cover the yard with several inches of soft coal cinders. Sun-porches with floors of three-quarter or one-inch mesh wire are also suitable. No one should be allowed to go into the houses without wearing rubber boots kept for that purpose. As older recovered fowl constitute the principle source of the spread of the infection to chicks, adults and chicks should not be allowed to run together. In acute outbreaks of *Eimeria tenella* and *Eimeria necatrix* infection it is better to kill the birds visibly affected and to burn their carcasses. Contaminated yards should not be planted, but should be frequently cultivated in order for the bare land to be exposed to the sunshine as much as possible. Such land should not be used for chicken raising for a year or two, as the parasite is quite resistant and may remain alive, in the soil for a considerable length of time, under ordinary conditions. In view of our present knowledge, sanitation is the keynote to successful control of coccidiosis, and clean dry ground, clean dry quarters, and frequent cleaning up of droppings are essential.

ENTEROHEPATITIS

(Blackhead)

This is an infectious disease affecting principally turkeys. Young chicken are also affected, but as a rule only a very small number in a flock show lesions of the disease when it is present, whereas it is quite common for a large number of turkeys in one flock to be affected. Other birds in which the disease has been demonstrated are the bob-white quail, pheasants, pea-fowl and ruffed grouse. However, enterohepatitis is primarily a disease of turkeys and the commonest one that we encounter in these birds. It may occur at any time from a few weeks of age up until the adult age is reached in turkeys. The disease is sometimes found existing in conjunction with coccidiosis in chicken. Adult chicken are very little, if at all, affected, but act as carriers of the parasite causing the disease.

Cause: A protozoan parasite, *Histomonas meleagridis*. The parasites live part of the time free in the cavity of the ceca (blind guts), but in another stage of the disease they burrow into the walls of the ceca and are carried by the blood stream to the liver. The organisms multiply in the ceca and pass out in the droppings.

Dissemination: Natural infection occurs largely through the medium of the cecal worm of chicken. Recovered chicken act as carriers, and the blackhead organisms are passed out by them in the droppings either free or enclosed in cecal worm eggs. (In connection with the cecal worm factor it should be noted that the worm eggs, because of their comparatively thick shells, are resistant to heat, cold, dryness or other adverse conditions, and can keep the protozoan alive in the soil from one year to another. Without this protection the protozoan seldom survives for more than twenty-four hours outside the body of the bird.) The infection is readily transmitted from the chicken carrier to normal chicken, and older ones become carriers without any indication of disease. Contamination of soil, feed and water by the droppings of an infected bird offers a ready means of spreading the condition. The disease has been readily produced experimentally in turkeys by feeding livers containing the organisms.

Symptoms: The affected turkey poults are drowsy and lacking in vigour and are therefore unable to keep up with the rest of the flock. The feathers are ruffled, wings droop, and there is a loss of appetite. Quite often there is a sulphur-coloured diarrhoea. In the later stages the head may become dark purple, hence the name "blackhead" which is given to this disease. This symptom, however, is not constant, and it is also found in other diseases in which there is a weakened heart's action. Death may follow in a few days after the symptoms appear. In older turkeys, diarrhoea, progressive loss of flesh, and weakness are seen, and the disease may last for several weeks followed by recovery or death. Frequently cases occur in the fattening pen in the fall that are the result of infection with the causative organism when the birds were young. Affected chicken appear very much like those affected with coccidiosis, but the droppings do not become bloody. The mortality is usually less than in an outbreak of coccidiosis, and the majority of the flock appear well.

Post-Mortem Appearances: The liver usually shows remarkable changes, and in almost every case it would be impossible to confuse the lesions with those occurring in other diseases. These lesions are yellowish-green round areas which may be mottled with apparently normal liver tissue, and are depressed below the surface. Sometimes only a few such areas are seen, but usually they are numer-

ous. One cecum, or both are thickened and distended with a dull gray crumbly or cheesy mass. The whole or only a part of the cecum may be involved. The lining membrane is ulcerated, and blood is frequently found in the material in the cecum.

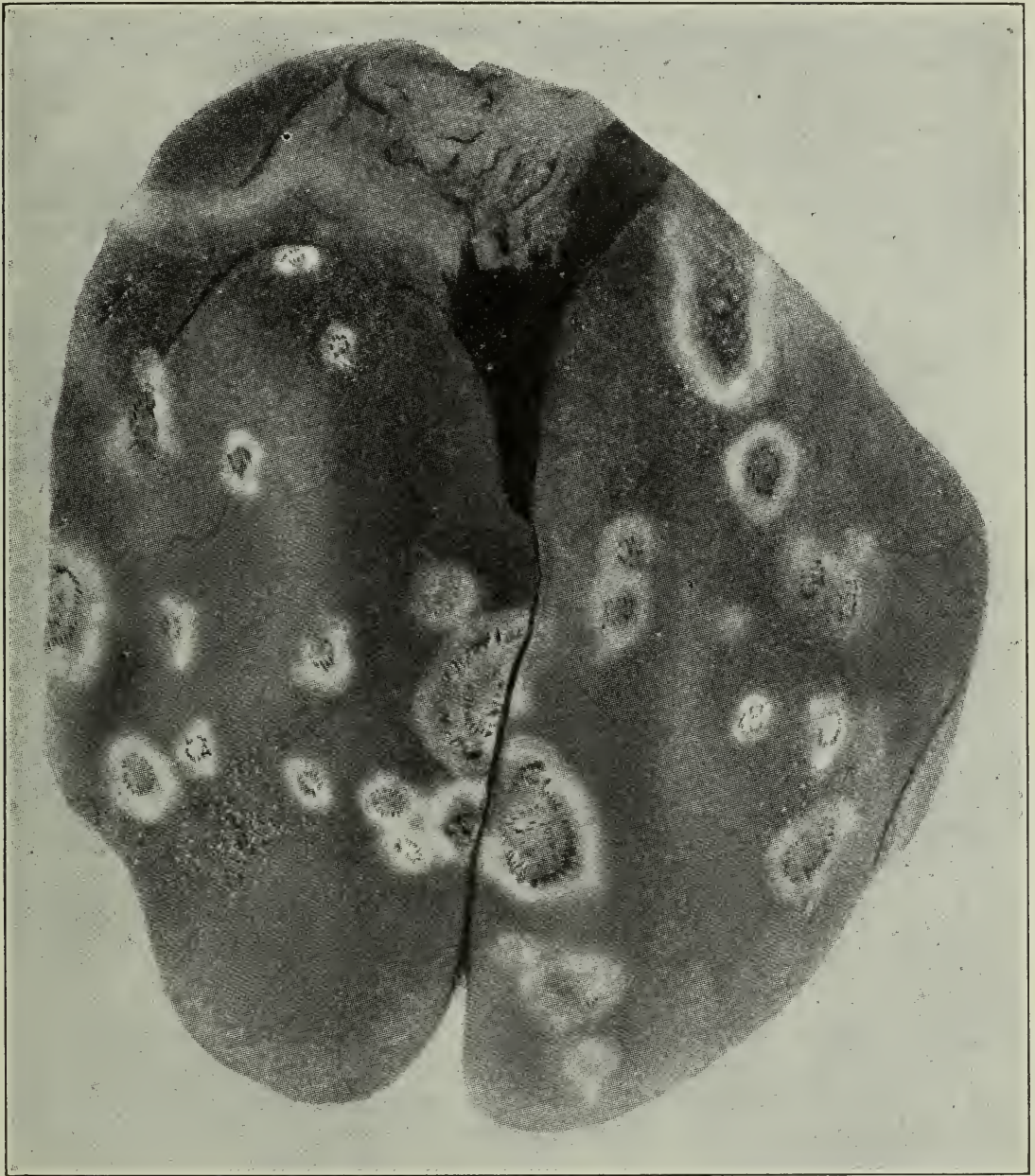


Fig. 24.—Turkey's liver with lesions caused by enterohepatitis. (After Brunett)

Mortality: The death rate in poults may be as high as ninety percent, but is much less in older turkeys and chicken.

Treatment: Although various medicinal agents have been used in this disease the results obtained have not been satisfactory. The only drugs showing any value at all are too expensive and difficult to administer. An antiseptic in the drinking water may assist in preventing the spread of the disease.

Prevention and Control: It must first of all be recognized that the chief sources of infection are chicken and turkeys ranging together, and land that has recently been occupied by chicken or fertilized with chicken manure. Separation of turkey poults from older turkeys and chicken, and fresh land are necessary. As

birds can become infected independently of the cecal worm, affected birds should at once be removed from the flock.

In some districts it is almost impossible to raise turkeys without taking special preventive measures. The following outline has been advocated for use under such conditions: Obtain eggs from birds believed to be healthy. Hatch in an incubator, or at least remove the eggs from under the hen a day or two before hatching and finish in an incubator, in order to avoid exposing the poults to the hen. Place the young poults in a brooder on enclosed ground at a distance from all domesticated birds, and not recently occupied by other fowl. Exclude, as far as possible, pigeons, wild birds, rats and mice from the houses and runs occupied by the turkeys. Frequently disinfect the houses, feeding troughs, drinking fountains, etc. Immediately kill diseased birds and burn the bodies. The turkeys should be confined in the enclosure until grown, and given sour milk or buttermilk frequently. When raising birds in confinement it is important that an adequate supply of green feed is included in the rations. Move the feed and water troughs a few feet each day after the birds are put on the range. This will prevent a concentration of the droppings at these points. It is important that the birds are afforded plenty of green succulent pasture, such as rye or rape. Sanitation and hygiene are extremely important in rearing turkeys, as blackhead is essentially a filth-borne disease.

DISEASES ASSOCIATED WITH THE FEMALE REPRODUCTIVE ORGANS

With the exception of *Salmonella pullorum* infection, diseases of the organs of reproduction of birds are not as a rule a very common occurrence. At times, however, severe losses do occur, and a brief description of some of these diseases is warranted.

OBSTRUCTION OF THE OVIDUCT

(Egg Bound)

Inability to lay an egg sometimes occurs in fowl, especially pullets. Probably the most common cause is the attempt to lay a large egg before there is sufficient dilatation of the oviduct sphincter muscle. It may also be due to inflammation of the oviduct, improper nourishment, malformation, tumours, stricture, twisting or paralysis of the oviduct.

Symptoms: Frequent efforts are made to lay. The straining causes inflammation, and in bad cases the oviduct may be everted through the vent or may rupture. If the egg is in the posterior part of the canal it may be felt through the abdominal wall. Death may occur from exhaustion if relief is not obtained.

Treatment: No treatment should be attempted until it is evident that the bird will not lay naturally. Then pour some olive or other oil into the cloaca, and with the finger of one hand inside and the other hand outside, endeavour to bring the egg out. The greatest care must be taken to avoid injuring the fowl. In cases where the egg cannot be delivered in this manner it may be broken with a blunt awl or nail, the contents and shell carefully removed, and the cloaca flushed out with cold water. If the condition is due to tumours, paralysis or lack of vigour it may be better to destroy the bird.

CLOACITIS

(Vent Gleet)

Cloacitis is an inflammation of the cloaca, and some authorities consider it to be an infectious venereal disease. However, extensive investigations by Goldberg and Benson (New York State Veterinary College), Gwatkin (Ontario Veterinary College), and Scherago (University of Kentucky), indicate that it is not transmissible.

Symptoms: The first thing that draws attention to an affected bird is the frequent passage of droppings, which are fluid and often rather clear in appearance. The mucous membrane is swollen and red. A discharge soon commences, at first thin, later thick, yellowish-white and very offensive. It sticks to the feathers and large masses may thus gather about the vent. The skin becomes inflamed and ulcers form at the juncture of the skin and mucous membrane. The droppings may become normal in a week or so, but owing to the irritation of the cloaca the frequency of passage persists. The condition may clean up in a week or ten days, often to reappear; or it may persist for months and though apparently healed, break out again. In one case the condition persisted for eight months, when it was apparently cured. The subsequent history of this bird is not known.

Post-Mortem Appearance: Birds seldom die from this condition, but in those killed for examination we have found inflammation of the cloaca, from two to four inches of the intestine and the posterior portion of the oviduct. No other changes are observed in the carcasses.

Treatment: Removal of the necrotic tissue and washing the parts with a mild antiseptic solution sometimes gives good results. Other treatments that have been recommended are to swab the affected parts at intervals of three or four days with a three percent solution of chromic acid, or a twenty percent solution of argyrol injected into the cloaca twice daily, or daily swabbing of the parts with a mercurochrome solution.

EVERSION OF THE OVIDUCT

(Prolapsus. Blow Out. Pick Out)

Eversion often follows the condition of egg bound, and occurs most frequently in pullets. The oviduct is congested or inflamed, and together with the cloaca is everted through the vent. We have encountered this condition more frequently in White Leghorns than in other breeds. It has been suggested that intestinal inflammation as the result of infestation with worms or coccidia is responsible for many cases of this condition, as prolapse of the rectum is usually associated.

Treatment: This is quite often successful if the condition is discovered in time. All affected birds should be promptly isolated or cannibalism will result. The protruding tissue should be carefully washed with warm water and then gently pushed back into place with clean fingers that have been covered with carbolized vaseline. The birds should be kept quiet and isolated for a few days. It is also advisable to make three or four injections of cold water each day. Cases that do not respond readily to this treatment, or if the condition recurs in the same bird, should be destroyed. Pick-out shields to protect affected birds are commonly employed.

RUPTURE OF THE OVIDUCT

This condition is not at all common. When it does occur the contents escape into the abdominal cavity, and peritonitis and death ensue. It is usually the result of a complicated obstruction of the oviduct, and is not recognized until a post-mortem examination is made. Investigations have shown that some cases of ruptured oviduct, if unaccompanied by other conditions, heal spontaneously.

INTERNAL LAYING

Hard masses of yolk material, yolks or imperfectly formed eggs are sometimes found in the abdominal cavity. They do not produce symptoms unless they collect in large quantity, when dropping of the abdomen and a carriage like an Indian runner duck is noticed, or becoming infected, give rise to peritonitis. Sometimes nothing can be seen to account for the condition. At other times it may be due to obstruction or injury to the oviduct, causing a reverse movement which carries the egg back into the abdominal cavity. Quite frequently we find the condition associated with *Salmonella pullorum* infection of the ovary. As the condition is not as a rule recognized during life, operative treatment cannot be tried, and even if the material were removed the cause would still be present, permitting the trouble to continue.

CYSTIC OVIDUCT

In most birds the right ovary and oviduct do not develop. In some cases where a right oviduct does develop it becomes filled with fluid. If much liquid is present the bird becomes very large behind and moves with difficulty. Thirty fluid ounces were taken from one cyst. The one illustrated contained fourteen ounces. Treatment is not practicable.

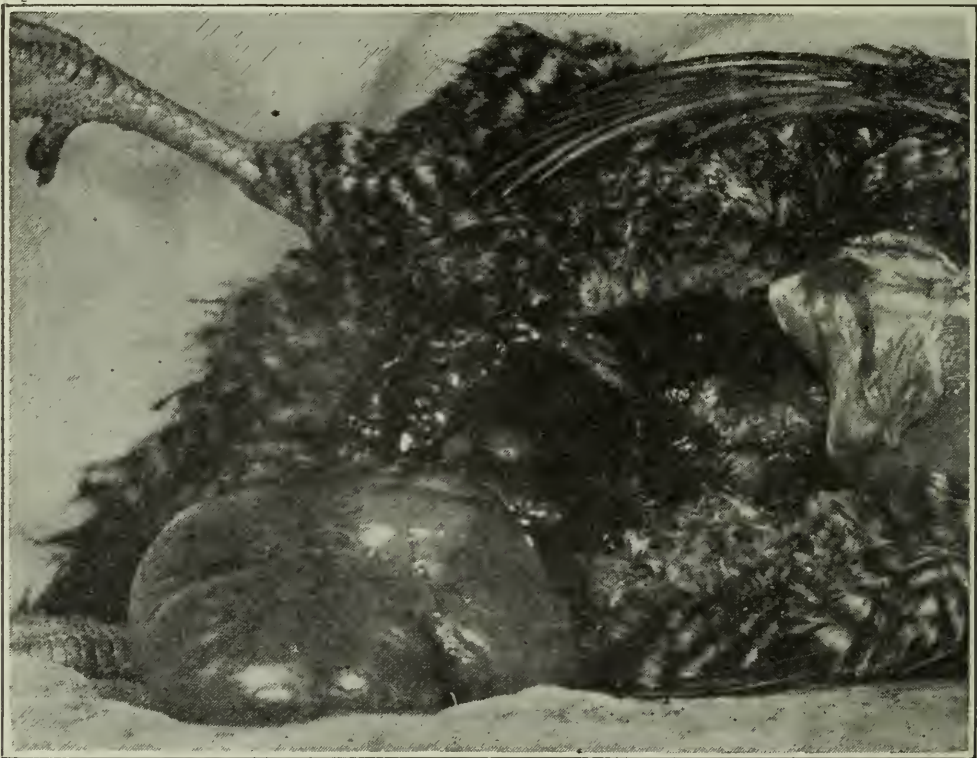


Fig. 25.—A cystic oviduct. (After Gwatkin)

MYCOSES

ASPERGILLOSIS

(Brooder pneumonia. Pneumomycosis)

This is a disease of the lungs, air sacs and air passages, and is due to a common fungus, the *Aspergillus fumigatus*. This fungus is widely distributed and is present in hay, straw, grain and other vegetable matter kept in damp places. In some parts of this continent the disease is of common occurrence, but it is apparently quite rare in Ontario. (Many deaths in chicks that have been considered due to this fungus were the result of lung infection with the causative agent of pullorum disease.) The disease attacks both adults and chicks, and only an occasional bird may be affected or a serious outbreak may occur. Ducks and wild birds have occasionally been found infected with the fungus. Infection results when mouldy material is used as litter or when mouldy feed is given. It has been suggested that some outbreaks in brooder chicks may be due to the penetration of eggs by the fungus.

Symptoms: In chicks the symptoms are similar to those seen in pullorum disease, and the birds die within a few days. In older birds catarrh is followed by obstruction of the air passages, and breathing is noisy. Birds become weak and remain by themselves. Diarrhoea and fever are present, causing sleeplessness and depression. The appetite is diminished, thirst increased, and in typical cases in the advanced stage, a foul odour is present. Involvement of the air spaces of the bones causes lameness and swollen joints. Emaciation occurs as the disease progresses, and after four or five days the birds become prostrate, comatose, and die. Young birds frequently die from suffocation. Young chicks live only a few days. Older fowl may live for several weeks.

Post-Mortem Appearances: Whitish or yellowish patches are seen on the lining of the air passages in the early stages. Later a mouldy growth is present. The infection may extend to other organs.

Prevention: Treatment is of no value. Prevention consists in avoiding mouldy litter or feed, providing proper sanitation and housing, giving plenty of good rations, and burning of carcasses of affected birds. The disease is unlikely to occur in flocks that are kept under good sanitary conditions and fed only clean feed.

FAVUS

(White comb)

This is an uncommon chronic, contagious skin disease, characterized by the formation of white areas on the comb and wattles of chicken, which in severe cases extend to the neck and other feathered portions of the body. The condition is transmitted quite readily from fowl to fowl direct, and can also be transmitted to turkeys and man. It is caused by a fungus, *Achorion gallinae*.

Symptoms and Lesions: Small white or grayish spots first appear on the comb and wattles. These spots may be round or irregular in form, and gradually enlarge until the whole of the comb or wattle is covered with a whitish layer. The parts affected become thickened with an uneven surface. If the condition spreads to other parts of the body the feathers fall out or break off. A mouldy odour is sometimes evident about very badly affected birds.



Fig. 26.—Favus (white comb). (After Sabouaud)

Prevention and Treatment: Usually when only the comb and wattles are affected recovery may take place without any treatment. However, all affected birds should be isolated, and those in which the condition is generalized should be destroyed. Various ointments have given satisfactory results when applied two or three times a week. Amongst them are: vaseline eight parts and creolin one part; vaseline twenty parts, formaldehyde one part; glycerin six parts, tincture of iodine one part. Correct any poor housing condition that exists.

THRUSH

(Moniliasis and Oidiomycosis)

Two other types of fungi occasionally produce disease in chicken and other birds. They are the *Monilia albicans* and the *Oidium pullorum*. The former has been found associated with diseased conditions more than the latter. The mouth cavity, crop, proventriculus, gizzard, gall bladder, intestine and cloaca are affected, and the disease is sometimes known as "sour crop". We have not recognized the disease here in turkeys, chicken or pheasants, but have seen some cases in emus in a zoo. The lesions consist of gray easily detached membranes on the parts affected. The mode of transmission is not definitely known, but Jungherr of Storrs Agricultural Experimental Station, Connecticut, is of the opinion that it is transmitted through the agency of the egg, presumably the shell. The mortality in outbreaks investigated was very high. Treatment is apparently of no avail, as the fungus is resistant to the ordinary disinfectants. To prevent the spread, when the disease occurs in a flock, it is suggested that powdered blue stone be added to the drinking water at the rate of one level teaspoonful to two gallons of water every other day during one week. (Only earthenware containers should be used for this treated water.) In addition the flock should be given an Epsom salts flush. Dipping of hatching eggs from an infected flock in some preparation that will destroy the fungus is also suggested as a preventive measure.

INTERNAL PARASITES

Intestinal worms merit serious consideration owing to their ravages to the poultry industry. Most flocks are more or less infested with one or more species of worms, which, when present in small numbers, may do little harm. Slight in-

festations, however, if unchecked, become serious through birds picking up more eggs or larvae. Heavy infestations may cause serious losses, both directly and indirectly. A heavily parasitized flock is unthrifty and more susceptible to other diseases. A large number of species of poultry worms have been described, but mention will be made here of only a few of the commoner ones found in Ontario flocks.

General Symptoms of Worm Infestation: The symptoms are not by any means constant or diagnostic, and a positive diagnosis is made only by finding the worms or eggs. If a bird is in good condition a few large roundworms will produce no symptoms of disease. However, a comparatively small number of capillaria or tapeworms will result in pronounced symptoms being shown. These include a gradual falling off in flesh with subsequent emaciation, retarded growth, persistent diarrhoea, paleness of comb and wattles, great thirst, weakness and ruffled plumage. Paralysis of the legs and blindness are common symptoms exhibited in tapeworm infestation, and at times "wry-neck" and "limber-neck" are seen in some of the affected birds. Worms secrete two kinds of toxins. One attacks and destroys red blood cells resulting in the paleness of the comb and wattles. The other toxin affects the nervous system and is responsible for the lameness and impaired vision.

Post-Mortem Appearances: Badly infested birds show an anemic condition of the carcass. Inflammation of the intestine is common. In tapeworm and capillaria infestation the mucous membrane of the intestine is thickened and roughened. The worms attach themselves to the intestinal wall thus injuring the lining and causing some hemorrhage. (These changes are more or less chronic and the damage is quite often never fully repaired even though the worms are removed.) One of the large tapeworms produces nodules in the intestinal wall which are similar in appearance to the nodules of tuberculosis. Rolled up masses of large round-worms may be found obstructing the intestine. If only minute tapeworms or capillaria are present it is necessary to make a scraping from the intestines and examine it under a microscope.

ROUNDWORMS

The three commonest roundworms found in birds forwarded to this laboratory for examination are the *Ascaridia lineata*, the *Heterakis gallinae*, and *Capillaria*. The *Ascaridia lineata* is found in the small intestine, and is from one half to four and a half inches in length. The female worm deposits its eggs in the intestine and these pass out in the droppings. Ingestion of the eggs by other fowl results in infestation. The *Heterakis gallinae*, commonly known as the cecal worm, inhabits the blind guts. It is about half an inch in length, and the eggs are passed out with the droppings. These worms apparently do little harm when confined to the ceca, but cases have been reported where they have migrated to the small intestine and caused considerable damage. They also play a part in the transmission of enterohepatitis in turkeys. *Capillaria* are minute thread-like worms found chiefly in the first portion of the intestines. On a gross post-mortem examination they may not be easily found, and are usually demonstrated by a microscopical examination of a scraping from the gut. A considerable amount of damage is done by these worms. Fowl become infested by ingesting the worm eggs that have been passed out with the droppings.

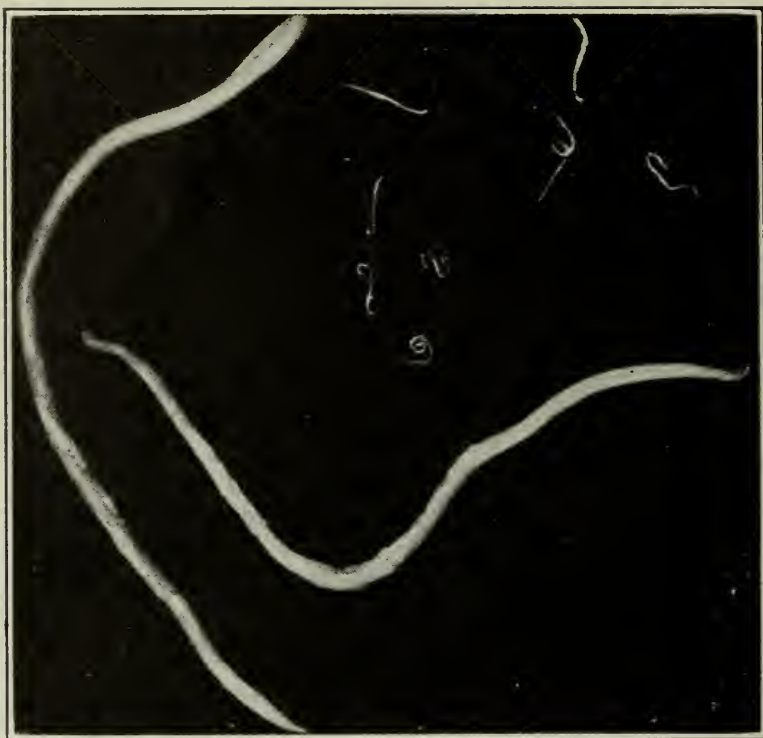


Fig. 27.—Large roundworms and cecal worms of chicken. (After Gwatkin)

TAPEWORMS

These are white, ribbon-like, segmented worms, which vary in size from microscopic to those easily seen. In order to become mature most tapeworms require an intermediate host. That is, in birds the mature tapeworms are present, and the eggs which are passed out in the droppings are eaten by flies, bugs, ground beetles or other insects in which they hatch and go into the larval stage. If these intermediate hosts are later eaten by susceptible fowl the larval forms develop into mature tapeworms. Probably the commonest tapeworms found here are the following:

Choanotaenia infundibulum, which varies from two to nine inches in length and is about one-eighth of an inch wide. It is found in the small intestines of chicken, turkeys, ducks, and pigeons.

Davainea proglottina, found in chicken and turkeys, and has only four or five segments. It is from one-fiftieth to one-fifteenth of an inch in length, and is barely discernible to the naked eye.

Raillietina echinobothrida, a parasite of chicken, turkeys and pigeons. It is from two to nine inches in length, and frequently produces nodules and ulcers in the small intestines.

Treatment and Control: The medicinal treatment of fowl infested with worms is not by any means effective in a large number of cases. Many supposedly satisfactory worm expellants are offered for sale, but on the whole they are only partially efficacious. The large roundworms may be fairly easily removed, but the "cure" is often worse than the "disease" when drugs are given to expel tapeworms. Nicotine sulphate (Black leaf 40) 6.6 cc's, and Lloyd's alkaloidal reagent 16 gms., mixed and placed in capsules in amounts of 0.35 to 0.4 gms. is fairly effective against the large roundworms. One capsule is given to each bird on a full crop. Carbon tetrachloride and tetrachlorethylene have been found of value in removing

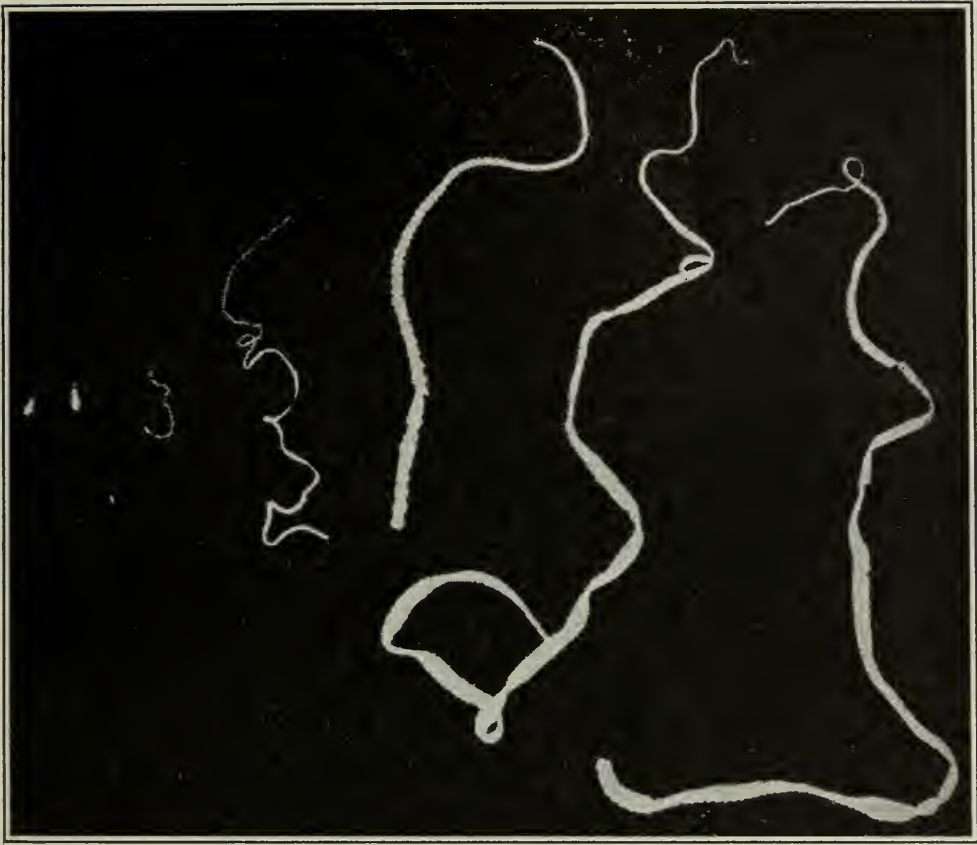


Fig. 28.—Seven different species of tapeworms from the chicken. Natural size.
(After Cram)

the large roundworm and capillaria. The dosage of either of these drugs is 1 cc. in a capsule, and three capsules are given each bird at intervals of one hour. (This dose is for mature chicken.) Rectal injections of carbon tetrachloride, 2 cc.'s in mineral or cotton seed oil 10 cc.'s, are recommended for the removal of cecal worms. Kamala is apparently the only drug which has any value in the treatment of poultry for tapeworms. 1 gm. doses of the powder in capsules or a 1 gm. Kamala tablet is administered to each bird. As this treatment has resulted in the deaths of several birds on some occasions it is recommended that the treatment be first tried out on a few of the weaker birds before treating the rest. In any event the drug should not be used if the birds are affected with coccidiosis, roup or any disease which has lowered their resistance.

In the control of worm infestations, sanitation and hygiene are of much greater importance than medicinal treatment. When birds are treated strict cleanliness and sanitation must be observed, the houses and yards being thoroughly cleaned to prevent re-infestation. Removal to fresh ground is even better. Failing this, the top soil, containing worm eggs, should be removed so that the birds cannot gain access to it. The land should be kept well drained as damp land is favourable to the development of the parasites. Clean up the droppings frequently, and prevent as far as possible the birds pecking in them. The worm problem must be attacked through the land. Rotation is absolutely necessary as constant running over the same ground produces a concentration of parasites which makes poultry raising unprofitable, and in fact almost impossible.

EXTERNAL PARASITES

Many different kinds of lice, mites, and other external parasites infest poultry and a brief outline of some of the more frequently observed ones will be given

here. As a rule, external parasites in Ontario are easily controlled, and they do not constitute such a serious problem as do the internal parasites. However, if unrecognized and allowed to remain unchecked, serious damage may be done to a poultry flock.



Fig. 29.—Three common species of lice on fowl. (Beach and Freeborn.)

LICE

(Mallophaga)

Several species of lice are found on poultry. The whole life cycle is lived on the birds, so that when the lice are destroyed reinfestation will not take place from the house. Lice cause loss of weight, lower egg production, and general lowered vitality of the flock. Some are found only on certain parts of the body, and are termed "head lice", "body lice" or "shaft lice" according to their location.

Treatment: Sodium fluoride has been found a satisfactory delousing agent. While not very rapid, it is thorough, and it is claimed that one treatment is sufficient to rid the birds of lice, as it remains on them long enough to catch the young after they emerge from the eggs, which are not injured by the treatment. However, it seems advisable to repeat the treatment in about two weeks' time. Sodium fluoride is applied in one of three ways: (1) by the pinch method (2) by dusting, and (3) by dipping.

The pinch method consists of placing on the skin of each fowl approximately twelve pinches (the amount held between the thumb and forefinger) of commercial sodium fluoride, distributed on the breast, each thigh, below the vent, on each side of the back, on the neck, on the head, and on the under side of each outspread wing. The excess powder is caught on a newspaper. In the dusting method the sodium fluoride is mixed with three or four times its bulk of flour or road dust, and applied with a shaker ruffling the feathers as it is being applied. Dipping can be practised in warm weather only, so that the birds will dry before nightfall. One ounce of commercial sodium fluoride is dissolved in each gallon of tepid water. The body of the bird is held under the fluid for about half a minute, ruffling the feathers to let the liquid in, the head is then ducked, and the bird held to drain for a few seconds.

Mercurial or blue ointment is also commonly used to kill lice.

It is mixed with from one to two parts of vaseline, and a small amount of the mixture is rubbed on the skin just below the vent. Lice are then killed by the ointment when they go to the vent for moisture. Caution must be exercised in handling blue ointment as it is very poisonous.

Nicotine sulphate (Black-leaf 40) is used quite extensively with excellent results. An hour or two before the birds go to roost the chemical is applied to the tops of the perches (which should be clean and have no lime or whitewash on them) with a small brush or an oil can. An ounce is sufficient for about thirteen feet of perches. Plenty of fresh air must be provided when the birds go to roost as nicotine is a potent poison and must be handled with caution. The lice are killed by the fumes arising from the drug.

Preventive measures consist of keeping boxes, containing fine dust to which is added some lice powder, available for the birds, and treating all new birds before adding them to the flock.



Fig. 30.—The common poultry mite, much enlarged. (After Gwatkin)

MITES

Common Poultry Mite: The common poultry mite *Dermanyssus gallinae* hides in cracks and corners during the day, infesting the fowls at night for the purpose of drawing blood. For this reason its presence may be overlooked. Fowls in a heavily infested house become droopy and listless. Occasionally some mites remain on the birds during the day.

Treatment: Thoroughly clean chicken house, removing and burning the straw, and spray with crude petroleum diluted with one part of coal oil to four parts of crude oil. The oil should be allowed to soak in to the wood before the birds are returned to the house. With this heavy preparation one application is usually sufficient. Coal oil or carbolic acid are effective, but lacking body, they must be repeated several times at ten day intervals.

Scaly Leg Mite: The scaly leg mite *Cnemidocoptes mutans* burrows under the skin of the legs, causing enlargement and roughness. The scales are pushed up by a crusty substance and project straight out, producing a roughened effect. In severe cases the joints may be inflamed, the birds are lame, and a joint or whole toe, may be lost. The birds may die of exhaustion from inability to scratch feed. The condition is transferable to other birds, but does not spread readily.

Treatment: Infested birds should be isolated. Wash the feet and legs with warm, soapy water and remove loose scales. Apply an ointment made of oil of caraway one part, and vaseline five parts. Many other remedies have been advocated, but this appears to be as satisfactory as any.



Fig. 31.—Scaly leg. (After Gwatkin)

Feather Mite (Tropical Mite): The feather mite *Lyponyssus bursa* differs from the common poultry mite by remaining on the birds practically all the time. Occasionally they are found on detached feathers in nests. The adult mites look like black specks, and when they come out on the feathers of a badly infested bird on a sunny day they make it look as if sprinkled with pepper. They are most commonly seen around the vent, but may be found anywhere among the feathers. They are very resistant to cold and starvation and may live many days when separated from the bird. They suck blood and when abundant, as they will become if the birds are not treated, they cause the fowls to become very droopy, and may even lead to their death.

Treatment: Thoroughly clean out the houses, burn litter and nest material, and spray with a mixture of crude oil and coal oil as described under the treatment for the common poultry mite. Crude oil can be obtained from any of the large oil companies. Coal oil alone, creosote oil or any of the coal tar products can also be used. Treat each bird by dusting heavily with sulphur. It is a good plan to use one part of sodium fluoride to four parts of sulphur, as this mixture will also be effective for lice.

Depluming Mite: The depluming mite *Cnemidoptes gallinae* may cause loss of feathers in birds during the spring and summer. It attacks the portion of the feathers beneath the skin. The feathers may be shed, or break off close to the level of the skin. The stumps may be cracked, and surrounded with scaly material. The mites may be observed on the stumps of the quills. The irritation caused may set up the habit of feather pulling. In severe cases egg laying may be interfered with, and the birds become emaciated and may die.

Treatment: Affected birds should be isolated, and sulphur ointment or oil of caraway ointment, applied to the affected parts.

Air Sac Mite: The air sac mite *Cytoleichus nudus* is just large enough to be seen with the naked eye. They may be found in the windpipe, lungs, air sacs, hollow bones, and the peritoneum. They are most commonly found in the air sacs. They do not appear to be harmful, for they may sometimes be found in large numbers in healthy birds. No form of treatment has yet been found for this mite.

Connective Tissue Mite: The connective tissue mite *Laminosioptes cysticola* is mostly found under the skin in places where it is loose, such as flanks, breast and neck. In yearling and older birds small white granules are observed, which are composed of lime salts that have been deposited round the parasites, as a reaction of the body against them. They are mostly seen in old fowl in poor condition, and apparently do no harm. Sometimes the condition is confused with tuberculosis, for which reason the parasite is mentioned here, as fowl affected with these white granules are suitable for food purposes.

MISCELLANEOUS CONDITIONS

ASCITES

(Abdominal Dropsy)

Ascites is characterized by an unnatural accumulation of fluid in the body cavity. Although encountered fairly frequently, the condition usually represents an isolated case in the flock.

Cause: Obstruction or disturbances of the circulation of the blood resulting from such diseases as tuberculosis, leucosis, lymphomatosis, or tumours are the primary causes of many cases. Ascites is usually the result of some other disease rather than a disease itself. It may follow cases of internal laying, rupture of the oviduct, or peritonitis due to mechanical injury.

Symptoms: The abdomen is distended with fluid, and an examination by a slight pressure of the hand will reveal it to be soft and fluctuating. As the condition progresses the affected bird becomes dull, appetite is diminished, the comb is pale, and there is weakness and a disinclination to move.

Post-Mortem Appearances: The internal organs are pale and anemic. A varying amount of colourless, yellow or reddish liquid is found in the abdominal cavity. Small whitish nodules are seen on the intestines and mesentery.

Treatment: In most cases treatment is not practicable. Tapping the abdomen and removing the fluid gives only temporary relief.

FROZEN COMBS AND WATTLES

The combs and wattles, especially of cockerels, frequently become frozen during extremely cold weather. The frozen parts are often swollen and painful, turn bluish red in colour, and may slough off. The comb does not swell to the same extent as do the wattles.

If only slightly affected the parts may be thawed out with snow or cold water after the birds have been placed in moderately warm pens. They should then be well greased with vaseline. It may be necessary to amputate the badly frozen parts after the swelling has subsided.

RUPTURED LIVER

This condition is frequently seen, and is usually the direct result of an injury. (An exception is rupture due to extensive tubercular lesions.) It has been suggested that nutrition may play a part in weakening the liver capsule. Only isolated cases have been observed here. Rupture of the liver results in internal hemorrhage and the affected bird dies suddenly.

BUMBLEFOOT

This term is applied to an injury of the foot when germs gain entrance through a cut or a bruise, causing a swelling which contains a liquid or cheesy material. Among the numerous causes leading to injury of the foot are unsuitable angular perches, jumping from high perches, stepping on nails, splinters, thorns, glass or coarse cinders. To prevent the condition, roosts without sharp edges, plenty of litter, and suitable runs should be provided. Individual treatment consists of opening the abscess, removing the pus and injecting the cavity with tincture of iodine. Although the treatment is simple some cases do not respond to it readily, and therefore have to be destroyed.

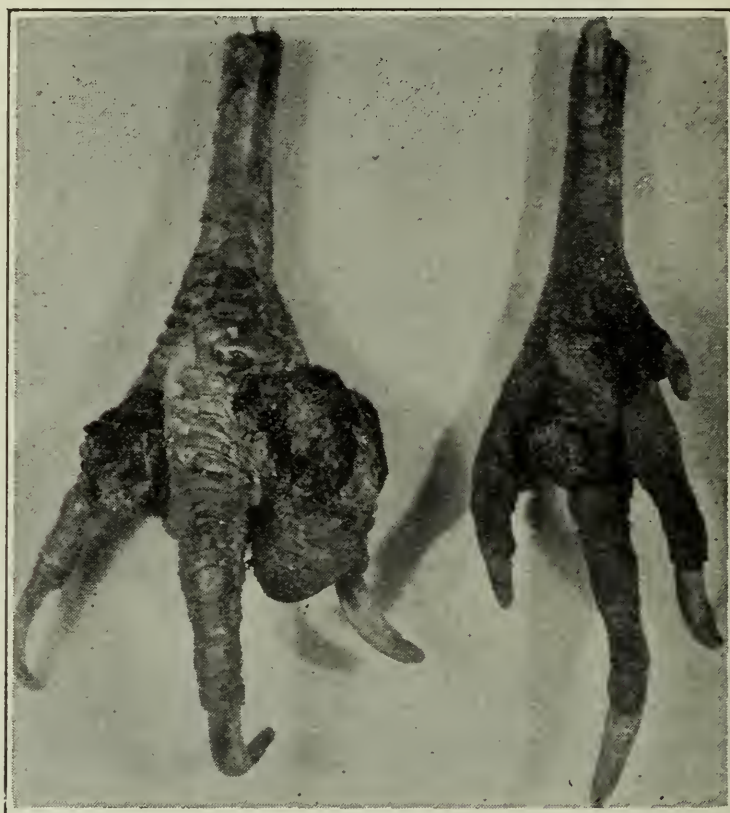


Fig. 32.—Unusual case of bumblefoot showing mass of hardened exudate on upper surface of one foot, and injury to the under surface of the other. (After Gwatkin)

CHOLERA-LIKE DISEASES

Outbreaks of diseases sometimes occur in fowl that closely resemble fowl cholera. The losses, however, are usually smaller. Bacteria belonging to the colon group, which are usually harmless, have frequently been found in the affected organs and are believed to be the cause. Hemorrhages in the heart are observed as in true fowl cholera. Control is the same as in that disease, the point of greatest importance being the cleaning up of droppings to check the spread of the infection.

STAPHYLOCOCCUS INFECTIONS

We have frequently received specimens for examination in which lesions resembling boils in humans were found on various parts of the body. A bacteriological examination showed *Staphylococcus aureus* to be present. This is the same organism responsible for boils. Only one or two birds in a flock were affected, and it is apparently not a very common condition. No treatment seems to be practicable as the healing of the lesion results in a scar which of course disfigures the carcass and makes it unmarketable.

TUMOURS

(New Growths. Neoplasms)

Tumours of various kinds are found in fowl, and are of quite frequent occurrence. They are sometimes found in apparently normal fowl, and principally in mature and old birds. The cause of tumours is not known. They are abnormal masses of new tissue of non-inflammatory origin, and arise from normal tissue. There are two principle types of tumours — benign and malignant, and there are several kinds of each of the two types. Benign tumours increase in size by central growth and do not spread. However, they may become enlarged to such an extent as to cause death by pressing on a vital organ. Malignant tumours are rapid in their growth, have a tendency to spread, and recur after removal. Most tumours are not infectious, but a few chicken tumours can be transmitted from one bird to another. The ovary and the liver are the commonest locations of tumours in fowl. They may also be found on the intestines, the mesentery, kidneys and other organs, and are usually in the form of whitish or pinkish soft masses. External tumours are also of frequent occurrence. It has been observed that tumour formation is quite common in some flocks and practically unknown in others. This would indicate that some strains of birds are more susceptible than others. We find here as a general rule that only one or two birds in a flock are affected with tumours, and this condition is therefore not of great economic importance. Treatment of tumours, even if recognized, is not of value unless the growths are external when they can sometimes be removed successfully. If however, such tumours were malignant, this would be only of temporary benefit, as they would probably recur.

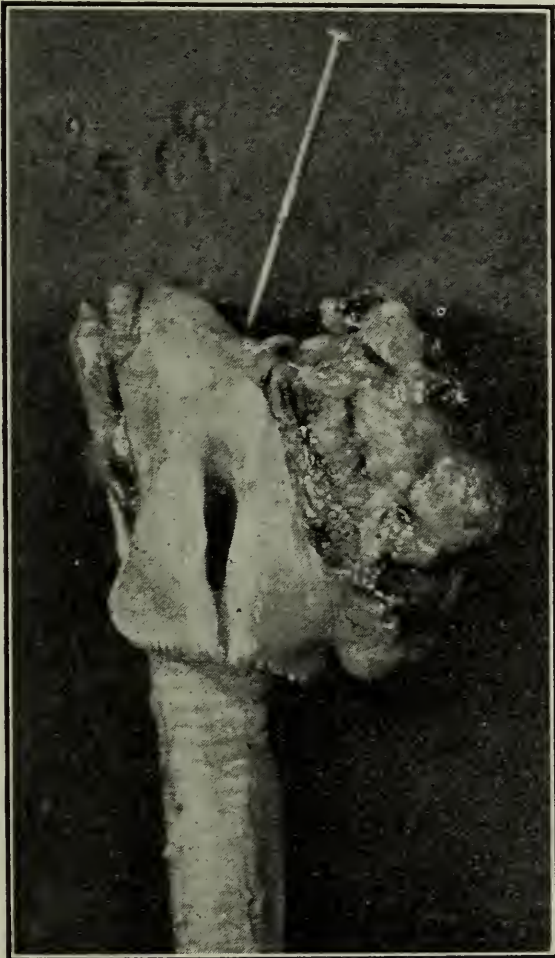


Fig. 33.—Tumour on larynx of fowl.
(After Gwatkin)

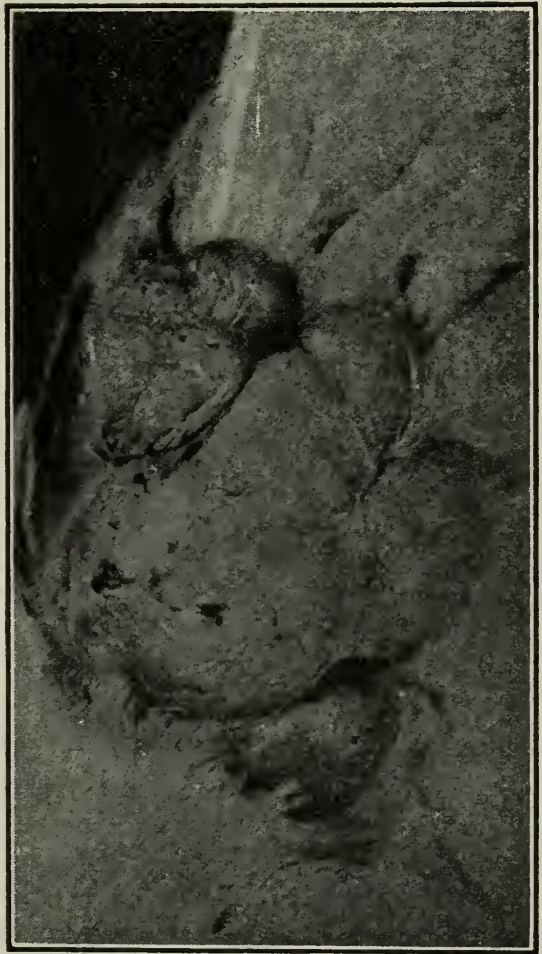


Fig. 34.—Tumour on wing of fowl.
(After Gwatkin)

PARALYSIS

Paralysis is a symptom commonly observed in several diseases of birds. When not accompanied by any abnormal changes due to nutritional disorders we find it most frequently in cases of tapeworm infestation and coccidiosis. More rarely it is seen in tuberculosis and cholera (in which the muscles of the neck are sometimes paralyzed).

A temporary paralysis has been quite often observed in laying pullets during the months of heavy production. Recovery usually takes place in from twelve to twenty-four hours without treatment. Pressure from an extra large egg, or irritation from prolonged stay of an egg in the oviduct have been suggested as explanations of this condition.

Paralysis resulting from nutritional disorders is fully discussed in the section dealing with these conditions.

The condition known as "range paralysis" has been dealt with under that heading. Too often flock owners have thought their birds affected with this disease simply because symptoms of paralysis were exhibited.

A thorough post-mortem examination of a paralyzed bird will usually reveal the cause of the trouble, and until this has been done no attempt at diagnosis should be made. When the real reason for the condition has been established treatment or control measures can be suggested.

POISONING

As a general rule the sense of taste protects fowl from many poisonous substances. Cases of poisoning, when birds are on the range, are rare, and it is usually when they are in confinement that the ingestion of poisonous substances takes place.

The effect of many poisons on fowl has not been studied to any great extent, and in many instances the cases cited in literature are those of single occurrence. It therefore seems advisable to confine our remarks in this bulletin to a few of the more common conditions.

Sodium Chloride: Poisoning by this substance undoubtedly occurs at times. Tolerance for sodium chloride (common salt) is not great in chicken, and many cases of this form of poisoning, either accidental or intentional have been reported. Brine, salt pork and fish containing an excess of salt or the feeding of clover or clover chaff from hay covered with salt, ingested by chicken have been known to cause death. Two to three drams of sodium chloride constitutes a lethal (fatal) dose for adults. No treatment has been of value, and it is suggested that not more than one percent should be used in mash.

Mercury: We have had occasion to observe the effect of mercury in fowl. We found that excessive applications of mercuric ointment (containing metallic mercury) resulted in emaciation, dullness, diarrhoea and paralysis. It was assumed that the poisoning was the result of ingestion of the excess ointment.

Nicotine Sulphate: Mention of the extreme toxicity of nicotine sulphate has been made elsewhere in this bulletin, and it should be used only where it has been suggested and only in the manner outlined.

Arsenic: Rat poisons containing Paris green or other arsenical preparations have at times been responsible for deaths in poultry. However, where reasonable precautions are taken, mortality from this form of poisoning rarely occurs. Birds should not be allowed to run in orchards for several hours after the application of arsenical sprays to fruit trees.

Rose Chafers: These beetles are extremely poisonous to fowl especially chicken under ten weeks of age. Preventive measures consist in keeping chicken away from the habitats of the chafers — rose bushes, fruit bushes, some grains and grasses. Destruction of the beetle is accomplished by spraying the shrubs with about ten ounces of lead arsenate in ten gallons of water.

Poisoning by Means of Spoiled Foods or Immature Grain has been mentioned in the section on sanitation. In Ontario we find that the feeding of grain that is new and soft causes serious losses in poultry flocks. A severe and extensive inflammation of the intestines is observed, and mortality is high.

Certain Seeds of Plants, if eaten by fowl, result sometimes in serious losses. The worm-seed mustard is an example, and if eaten in large quantities results in inflammation of the stomach and intestines.

Tin or Zinc Containers should not be used for sour milk, buttermilk or water treated with medicinal agents. Many cases of poisoning have occurred when this practice has been carried out, and it often happens that deaths do not occur until several weeks after first using such containers for these purposes.

Sodium Bicarbonate, that has often been recommended as an intestinal flush, often produces symptoms of poisoning.

Poisoning Due to Gasses from improperly trimmed lamps in brooders has been reported at times.

In view of our present knowledge it would appear that when the rare cases of poisoning occur preventive and control measures to protect the rest of the flock should be established.

USES AND DOSES OF SOME OF THE DRUGS USED IN POULTRY PRACTICE

Although we do not recommend the extensive use of medicinal agents in combatting poultry diseases, occasions arise when some treatment is of value. Some of these remedies, together with their indications, are listed here.

Epsom Salts (Magnesium Sulphate): Is useful as a flushing agent in certain conditions. One half pound is dissolved in about two gallons of water for one hundred mature fowl. The ordinary drinking water should be withheld in the morning until the birds are thirsty and they will then drink the treated water. Fresh water should be given them about an hour after.

Carbon Tetrachloride and Tetrachlorethylene: Used to expel certain roundworms of poultry. They are administered in doses of one cubic centimeter in gelatin capsules.

Kamala: A drug that is used in tapeworm infestation. It is considered unsafe for turkeys. The dose for mature chicken is one gram.

Argyrol: Is often used in the eyes or nose as an antiseptic in a ten per-cent solution. It is non-irritating.

Tincture of Iodine: Is a useful antiseptic for wounds. No bandage or dressing should be applied to a wound treated with tincture of iodine.

Tincture of Ferric Chloride: Will reduce the amount of bleeding from small wounds, and is useful following cropping of the wattles or dubbing of the comb.

Mercurial Ointment: Diluted with one or two parts of vaseline is very effective as a delousing agent.

Sodium Fluoride: One ounce of the powder to each gallon of warm water is used as a dip for lice infected birds.

Sodium Fluosilicate: Is used as above and is considered by some to be superior to sodium fluoride.

Potassium Permanganate: One third teaspoonful is added to each gallon of drinking water in outbreaks of contagious disease. It, however, soon loses its antiseptic power on account of rapid deoxidation.

Nicotine Sulphate: Is extremely poisonous if taken internally. It is very useful as a fumigant against lice, and should be used only as directed.

DISINFECTANTS

Disinfectants play an important part on a well managed poultry farm, and those commonly employed are listed below. It is important that a thorough cleaning precede the disinfecting, so that the agent used can thoroughly penetrate into cracks and crevices.

Carbolic Acid (Phenol): Used in a five percent solution, but is more expensive than some of the other equally efficient disinfectants.

Cresol: This is a reliable agent and is used at the rate of one quart to twelve gallons of warm soft water.

Compound Solution of Cresol: Mixes readily in water. One quart of the solution of cresol to seven gallons of water makes an efficient disinfectant.

Formalin: Is a powerful disinfectant, and is employed for this purpose in about a ten percent solution. It is very irritating to the eyes and skin.

Chlorinated Lime: Six ounces of the powder are used to each gallon of water. It is a deodorizer as well as a disinfectant.

Iodine Suspensoid: Is extensively used to destroy coccidial oocysts, One pound of iodine suspensoid is mixed with twelve gallons of water in a non-metallic container and is used to scrub floors, dropping boards and perches.

Lye: A two to three percent solution of lye is an inexpensive and efficient germ destroyer.

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BULLETIN 395

JULY, 1938

Ontario Department of Agriculture

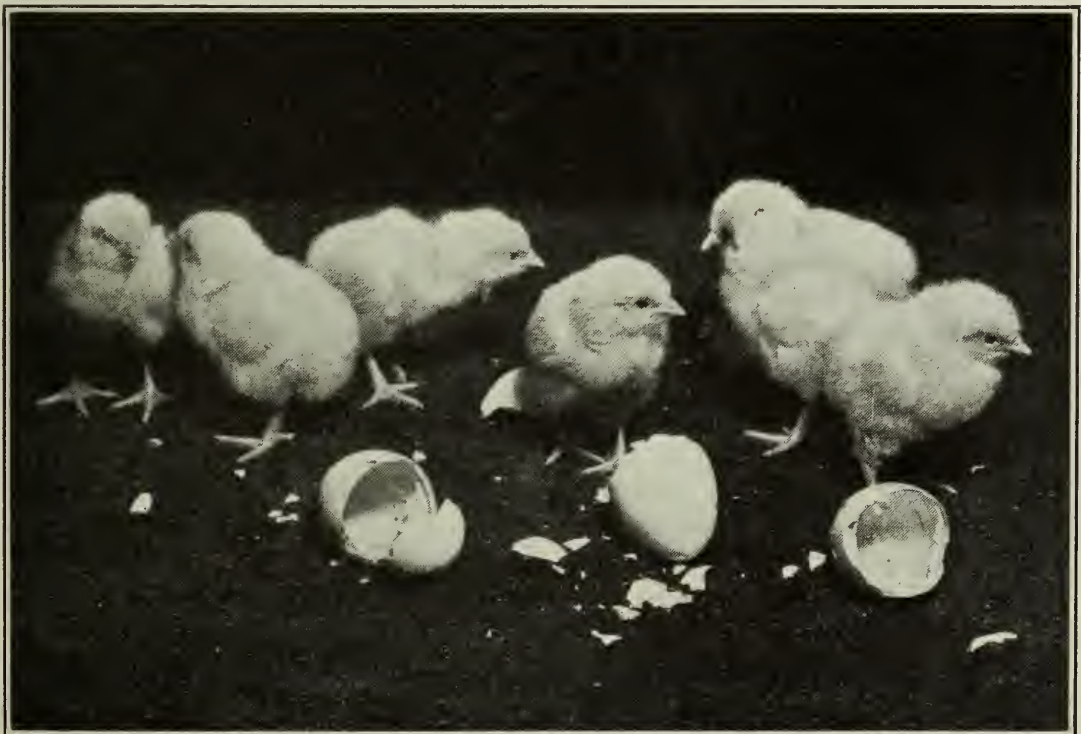
Statistics and Publication Branch

TORONTO, ONTARIO

FARM POULTRY

BY THE STAFF OF THE
DEPARTMENT OF POULTRY HUSBANDRY

ONTARIO AGRICULTURAL COLLEGE



There are many perplexing questions in connection with successful poultry raising on the farm. This bulletin answers some of them and will help the reader to find answers to others.

EGG PRODUCTION

It is generally considered among poultrymen that the production of eggs is the most profitable branch of the business. It must also be conceded that for most people a crop of chickens must be reared annually, and the surplus males and old hens sold, at a profit if possible.

Many believe that the secret of getting eggs, particularly in Winter, is in the feeds given and in the method of feeding; others believe the whole problem is in the breed, variety or strain; while still others think that the housing is the problem to solve. All these are important but the main reason for poor results, in the opinion of the writers, is a lack of careful work performed months before the eggs are wanted. While you are collecting the high-priced Winter eggs you should be making careful plans to secure the crop of pullets for the next season.

The factors influencing production are as follows: Feeding, housing, age of stock, strain, possibly breed, attendance, cleanliness and the weather. All of these may be more or less controlled, with the exception of the weather and it is perhaps the least important factor.

Some trouble is caused through over-crowding of the birds in the houses and having stock of mixed ages in the same pen. Often yearling and older hens are housed together with early and late pullets, as well as surplus cockerels. The pullets should be separated from the older females and any spare cockerels disposed of or housed by themselves. Dirty, damp and draughty houses, along with wet and badly soiled litter, are other causes of trouble.

Where Winter eggs are wanted, the early hatched pullet is, without doubt, the one to depend upon. Yearling and older hens are very rarely good producers during November and December. They are uncertain producers even in January and February and really do not begin to lay well until March unless artificial lighting is used. Where the egg production falls below twenty-five per cent. during the Winter months one is not making much profit. The age at which most pullets begin laying is from six to seven months. Some lay at four and one-half to five months, and others not until eight or nine months of age. This means that if a fifty per cent egg yield is wanted in November the pullets should be hatched during March or April. May hatched pullets will lay moderately well but, as a rule, not over forty per cent daily.

The attendant has responsibilities. There should not be any neglect on his or her part, but careful, constant, regular attendance and a keen interest in the welfare of the birds. A bird that has stopped laying is very hard to bring back into production. As pullets mature they commence laying. It is the attendant's work to keep them going.

The amount of feed a hen will consume, the number of eggs she will lay, and the time at which she lays the eggs, are interesting and important factors. Available data would indicate that one hundred to one hundred and ten eggs per year will pay for a hen's keep, depending on the market prices for feed and eggs, and provided the flock mortality is not in excess of ten per cent.

The body weight must be maintained or increased if production is to be kept up.

The amount of feed consumed varies with the breed and with the number of eggs produced. Our figures show that the general purpose breeds, such as Plymouth Rocks, Rhode Island Reds and Wyandottes, consume from eighty to ninety pounds of grain and mash annually, averaging nearly seven pounds of feed each month. Breeds such as Leghorns or Anconas eat from fourteen to eighteen pounds less per year; or in other words, the large breeds eat more than the small ones and the heavy layers eat more than the poor layers. The amount of feed required cannot be stated in ounces per bird for each day as birds' appetites vary, similar to human beings. The successful feeder studies his flocks and regulates the amount of feed to be given according to the condition and requirements of his flock. The writers are of the opinion that there are more hens that are too lean to lay than there are hens that are too fat to lay. Most very fat hens are poor layers and are better put on the market than fed sparingly to try to condition them for laying.

The common practice is to feed about one-half of the grain as scratch feed or whole grain, and the balance as ground mixtures or mashes.

There is a demand for information as to exactly how much to feed one hundred hens daily. This number of laying hens would eat about twenty-three pounds of feed daily, or say twelve pounds of scratch grain and eleven pounds of mash. Hens are inclined to eat more mash in the Spring and Summer months than during the Winter months.

It is not good practice to feed an exact amount daily because the hens' appetites vary according to the weather conditions and the rate of egg production.

Our method is to feed about four pounds of scratch grain per hundred birds, in the litter, in the morning. We generally give a moist mash at noon, giving the birds all they will clean up in fifteen minutes. At night a full feed of grain is given in a trough and any that is not eaten is removed. The dry mash is fed in a hopper and is constantly before the birds. The hopper should be large enough to allow a feeding space of one foot for each four or five hens. The amount of mash put in the hoppers should be such that it is cleaned up daily. Fresh feed is eaten more readily than after it becomes stale. This plan insures that the birds have all they desire to eat daily.

Hens usually ease off in egg production owing to a loss in body weight, hence the importance of having them consume approximately equal quantities of grain and mash.

The Art of Feeding. There is something in the art of feeding. A good feeder watches the condition of the droppings as seen on the dropping boards and also sees to it that the hens have plenty to eat but have no feed left in the litter. The appetites of the birds are keen and, moreover, the birds may like or dislike the attendant. There should be a friendly relationship between the attendant and the birds. Know your birds and have them know you. Be on friendly terms with one another.

FEEDS AND FEEDING

Fowl require a variety of feeds. While it is true that the whole grains, and the milling by-products from the same, form the major portion of the ration, it is absolutely essential that they receive also green feed, animal protein, water, grit and shell-forming material. All these feeds must be clean and wholesome. The drinking material should be constant in supply and may consist of water or milk or both. Where milk is given do not use galvanized iron or rusty containers. The supply must be clean because dirty water, dirty or slimy drinking dishes, etc., are probably the most common channels for the spread of disease. Most attendants are inclined to forget the importance of cleaning the drinking vessels and of keeping them well filled at all times.

Recent investigations with regard to nutrition have helped to clear up some points relative to feeds and feeding.

A complete ration contains all the necessary nutrients for health, growth, egg production or fattening. This means that such a ration is balanced in its tissue forming elements, such as contained in animal proteins, and in its heat and energy producing constituents, as are found in the cereal grains. It is also balanced in its mineral content, as commonly supplied in the form of oyster shell and bone meal, and includes the necessary supply of vitamins, as commonly found in tender green feeds, cod liver oil, and as activated by the ultra-violet rays in direct sunlight.

The experimental results to date suggest that the feeding of a variety of feeds is a safe practice. This applies to the use of cereal grain mixtures, such as corn, wheat, oats and barley, as well as in the use of animal proteins, such as milk, beef meal, fish meal, etc.

Any trials which we have made using a single cereal have always indicated that there is a deficiency of some nature in each grain and that this is also true of the animal proteins.

It is essential that the health of the bird be maintained and that there be a surplus of digested feed above that needed for body maintenance, to be used for growth or the production of eggs.

In general, it will be safe to state that grains such as wheat, oats, barley and corn, together with their mill by-products, maintain the body temperature and produce fat and egg yolks. Such feeds as skim milk, dried milk, or any other of the many forms of milk, together with animal by-products such as meat meal, fish meal, liver and proteins of vegetable origin, such as soya bean oil meal, go to the production of the muscle of the bird and to the making of the white of the egg.

Feeds such as bone meal, oyster shell, salt and minerals from other sources are used to produce the bones of the body, the shell of the eggs and certain parts of the various tissues and fluids in the bird's body. The whole series are required to produce eggs.

Many of the nutrients, other than those cited above, are found in small amounts in some feeds. As an example, there is considerable calcium and phosphorus in milk and in clover leaves, although milk is generally considered as a protein supplement and clover leaves as a substitute for green feed. Wheat bran also contains some bone-forming material.

An understanding of the feeding of poultry is helped materially by remembering that the bird can re-combine many nutrients, but can manufacture very little, if anything, not found in the ration.

A ration must be considered not only from the standpoint of its chemical composition, but also from its physical action, and it must be palatable.

It is also well to bear in mind that any change in the colour of the feed must be taken into consideration when one attempts to change the ration for the reason that many birds do not take kindly to the change and, moreover, it may change the colour of the yolks, which in turn may make a marketing difficulty. All changes should be gradual.

The physical factors influence the bulk of the ration or the weight per measured bushel and, likewise, the mechanical texture of the feed as to whether it is granular or sticky. Ground corn tends to be granular, whereas finely ground oat groats and wheat flour are sticky. Bran and clover leaves add bulk to the ration. Some feeds tend to be constipating, while others are of a laxative nature.

Where laying hens or growing chicks are given the free choice of a large number of feeds, prepared in different ways, it is seldom that very finely ground materials are selected. As an example, the birds prefer rolled or crushed oats to finely ground oats, so much so that they scarcely eat any finely ground oats where the crushed or rolled material is available. Where feeding space permits the placing before the birds of a large assortment of feeds, they will of free choice take in a great variety of these feeds.

The palatability of any mixture and its physical nature are important points.

Poultry that have been well fed during the growing stage are inclined to be sensitive to changes in feed mixtures, hence it is sometimes difficult to change from coarse to finely ground feed. It is a good practice to grow the young stock on the kind of feed you intend to use during the winter season.

There are two distinct conditions that have to be considered in grain mixtures. There are the persons who grow their own grain and who do not want to buy any other feed, and there are those who are in a position to purchase feed to be combined in the best known manner.

A very skilful feeder will observe closely the general condition of the birds' appetites, their general actions and the condition of the manure and will usually get results in growth and production which the ordinary feeder does not equal.

For most feeders a ration is desired that is as nearly fool-proof as possible; one that the birds may help themselves to at all times and with which the results will be positive, regardless of the efficiency of the attendant.

Laying hens, particularly during the Winter months, are sensitive to changes. Roughly speaking, if they have good care and feed for six days a week and the seventh day is not just what it should be, they are very likely to lay according to the attention given on the inefficient day.

RATIONS FOR LAYING HENS

Our experience suggests that there should be, if possible, three kinds of cereals available. Most people use as a scratch grain a mixture of about two parts whole wheat to one part of cracked corn. We have successfully used wheat, oats, barley, buckwheat and corn in grain mixtures. If care is used to make changes gradually we have no data that would suggest that any two, or preferably any three, of the above mentioned grains cannot be used. Elsewhere in the Bulletin are given the results of some experimental tests of the cereals in various combinations. While this work was done with chicks the results may, in some measure, apply in the case of

older birds. This may be true more particularly in respect to the combination of cereals, as suggested above.

Herewith is given a number of rations for laying hens. These are based on the results of experimental work and offer some latitude in the use of home-grown materials.

Cafeteria or Free Choice Laying Mash

400 lbs.	ground yellow corn		
100 "	yellow hominy or corn feed		
200 "	white hominy		
410 "	rolled wheat		
150 "	wheat germ or	{ 75 lbs. wheat germ	
		{ 75 " wheat middlings	
50 "	wheat bran		
100 "	rolled barley		
300 "	crushed oats		
50 "	oat middlings or oat feed		
20 "	ground peas		
20 "	soyabean oil meal		
80 "	meat meal	} or {	80 lbs. meat meal
30 "	fish meal		30 " fish meal
30 "	powdered milk		40 " powdered milk
10 "	cod liver meal		
10 "	iodized salt		
40 "	cod liver oil (or other fish oil) containing about 1,000 international units of Vitamin A and 100 international units of Vitamin D per gram.		

Bone meal, oyster shell and grit to be supplied in separate, accessible hoppers.

Laying Mash

500 lbs.	ground barley
200 "	chopped or ground yellow corn
320 "	ground oats
500 "	shorts
50 "	oil cake meal
15 "	iodized salt
150 "	alfalfa meal
125 "	powdered buttermilk
60 "	fish meal
40 "	meat meal
40 "	cod liver oil, or other fish oil

Bone meal, oyster shell and grit to be supplied in separate, accessible hoppers.

This formula is made with the idea that hens fed the mash will lay well and, at the same time, produce an egg that will hatch moderately well.

A number of people wish to use home-grown feeds and are asking how changes in the ration may be made to use such feeds.

Barley is used in this ration as a substitute for an equal quantity of corn, where the latter is relatively higher in price. Barley is low in vitamin A and is slightly high in fibre. Usually one need not worry about this amount of fibre but the vitamin A is essential.

Ground wheat could be substituted for the shorts, or some bran and low grade flour may be used.

Mixed grain may be substituted for all the grain mixture in the above mash provided it does not contain more than 40 lbs. of oats to the hundred pounds of mixed grain. If it has too many oats one should sift out a considerable quantity of the oat hulls, and the grain mixture will answer. Rolling or crushing the barley, oats and wheat would probably improve the physical condition and palatability of this mash.

The oil cake meal is put in the ration mainly to regulate the bowel action of the birds.

Ordinary fine table salt will do but we prefer to use iodized salt since there may be an iodine deficiency in some localities.

Alfalfa hay or clover leaves, or even fine cut clover hay, may be substituted for the alfalfa meal. This may be fed in wire baskets.

If there is available an ordinary pailful of skim milk for each hundred hens per day, all the powdered milk, fish meal and meat meal may be left out of the ration. Powdered milk is easily mixed into a ration and milk in one form or another appears to materially improve the hatching power of eggs.

Cod liver oil is essential during the Winter months to aid in making available the minerals, and is a good substitute for sunshine.

The protein feeds (milk, fish and meat meals) are used in the production of egg whites. The yolk is formed chiefly from the grains. The clover and alfalfa meals and the cold liver oil supply some of the essential vitamins.

This mash is kept constantly before the birds.

Crushed Grain Laying Mash

Crushed or rolled grain is preferred by chickens to finely ground grains, particularly such grains as wheat, oats and barley. These grains when ground and wet are of a sticky nature and this may be the reason for the hens' preference for crushed grains. The refuse hulls should be removed daily.

Good results in egg production and hatching power of eggs were secured in 1934 and 1935 from a ration consisting of equal parts of:

Crushed Oats
Crushed Wheat
Crushed Barley

To each one hundred pounds of the above grains was added one quart of a good grade of cod liver oil from November 1st to April.

It is necessary to feed some clover leaves or hay and to supply animal protein such as milk powder, beef meal or fish meal, or all three, in separate hoppers or containers. These feeds do not mix well with crushed grains. Birds to date have shown no disposition to eat an excess of these materials if supplied constantly.

Skim milk or buttermilk fed at the rate of twenty-five pounds daily to each hundred hens, provides enough animal protein without supplying any other, such as fish meal or meat meal.

The best hatches were secured from the eggs laid by hens receiving milk only as the animal protein.

Supply a hopper each of bone meal, oyster shell and grit.

If care is given as to feeding a reasonable amount of crushed grain daily, there will be little wastage. Where the birds are forced to eat all the hulls there is at times trouble with their gizzards becoming impacted sufficiently to cause death.

Feed scratch grain, as usual, of the kinds of grain you have. You could feed whole wheat as scratch grain, and crushed oats and barley as a mash.

NOTE: The results reported in this Bulletin regarding the dosage of cod liver oil are based on the use of medicinal cod liver oil at a minimum of one percent of the total ration. If oils of lower potency are used it may be found necessary to use a larger dosage. If using a fortified oil the dose could be reduced according to the degree of fortification. It should be borne in mind that laying birds consume, on the average, about equal parts of mash and grain. The oil is generally mixed in the mash and hence if one percent of oil is desired in the total ration, two percent must be mixed in the mash.

Feeding for Hatchability

Research in this Department, as discussed elsewhere in the Bulletin, has shown that a special hatching ration for breeders is necessary in order to produce eggs of high hatchability. Replacing such animal protein supplements as meat meal and fish meal with milk powder results in a higher percentage of chicks from the fertile eggs incubated.

Herewith is given a hatching ration. If liver meal can be obtained, it can be satisfactorily substituted for about half of the milk powder. The change from a laying ration to a hatching ration should be made gradually. In order to obtain the best results, birds must be fed the hatching ration for some weeks prior to the time it is desired to save eggs for incubation. Access to good pasture and sunshine, when the weather and other conditions permit, will also aid hatchability.

Cafeteria or Free Choice Hatching Ration

400 lbs.	ground yellow corn	
100 "	yellow hominy	
135 "	white hominy	
410 "	rolled wheat	
40 "	wheat germ	
100 "	wheat middlings	
50 "	wheat bran	
100 "	rolled barley	
340 "	crushed oats	
50 "	oat middlings	
20 "	soyabean oil meal	
200 "	powdered milk or	{ 160 lbs. powdered milk
		{ 40 " cereal grass
10 "	iodized salt	
5 "	bone meal	
40 "	cod liver oil (or other fish oil) containing about 1,000 international units of vitamin A and 100 international units of vitamin D per gram.	

Bone meal, oyster shell and grit to be supplied in separate, accessible hoppers.

FEEDING CONCENTRATES

High Protein Feeds

Several concentrate mixtures are sold by the trade. In most instances these feeds are recommended to be fed mixed with home-grown grains. With the grinding

or crushing of some home-grown grains it is difficult to make a thorough mixture of all the ingredients.

During the past few years we have been doing a little experimental work with placing the concentrate in a separate hopper or container and trusting the birds to eat what they require. We were interested, primarily, in ascertaining whether the birds over-eat of the concentrate, whether such a method is economical, and whether the birds eat more than they require.

There has not been sufficient data to warrant a positive statement but where chickens were grown on a reasonably good ration they have not consumed more concentrate than is recommended in most mixtures. Separate containers of powdered milk, semi-solid buttermilk, fish meal, meat meal, mixtures of milk, meat and fish, as well as liquid milk, have been given the birds.

Where liquid milk is given, a twenty-five pound pailful daily for one hundred laying hens has given ample protein supply. It is worthy of note that hens on a milk ration eat much more bone meal than they do on a ration of meat meal or fish meal.

When using a concentrate during the Winter the attendant should be sure to supply cod liver oil at the rate of a teacupful daily to three hundred hens. This may be poured on the whole grain, in which case the grain would be fed out of a trough to avoid contact with filth and dirt from the litter, by oily grain given in scratch material. The oil may be mixed easily when a moist mash is fed but is difficult to mix with finely ground grains.

Fifty laying hens will eat about one pound daily of meat meal when fed separately, which appears to be expensive but is not more than is mixed into many mashes. The birds' appetites for concentrate vary, depending much upon whether they are laying or not.

TABLE No. 1—FEED CONSUMED

Description	Milk	Grain	Mash	Grit and Shell	Special Animal Feed	Eggs Laid
	lb.	lb.	lbs.	lbs.	lbs.	
2375 Barred Rock Pullets	235,698	128,102	42,625	6,372	.....	381,503
Av. per bird	99.24	53.51	17.94	2.21	.....	160.6
1312 White Leghorn Pullets..	102,963	50,535	23,725	3,233.5	1,569.5	197,813
Av. per bird	76.11	38.51	18.08	2.46	1.19	150.7

In Table No. 1 are given the results of some investigation in feeding. The work has been carried on over a period of six years with Barred Plymouth Rock and Single Comb White Leghorn pullets hatched at different dates between March 1st and May 31st. The birds were, for the most part, kept under rather closely confined conditions, the yard providing in most cases only sufficient room to allow the birds to get out of the pen and onto the soil.

In computing the above data, feed used in the form of green feed was not included. The main consideration in this connection, however, was the oats used for sprouting purposes. It is difficult to determine the exact amount of this particular feed consumed by each bird. In observations and calculations made during the four year period, during which time sprouted oats were fed throughout the entire year, it was found that the consumption was approximately fifteen pounds for Leghorns and seventeen pounds for Rocks. Thus it will be found that if these amounts are added to the amounts of grain and mash given in the above table that the total grain consumption per bird per year was for Leghorns 71.59 lbs., and for Rocks 88.45 lbs.

A study of the distribution of the egg production is interesting and important from the standpoint of the annual returns from the birds. Egg prices rise and fall with the seasons and usually the greatest profit is made where eggs are produced at a season or seasons of the year when prices are high.

Pullets are the chief source of egg supply. As stated previously, they require usually from six to seven months in which to mature. It is therefore possible to regulate their production in the Fall months, at least to some extent, by regulating the time they are hatched in the Spring. Below is given the average percentage monthly egg production of Barred Rocks and White Leghorns hatched in March, April and May for a period of six years.

TABLE No. 2. AVERAGE PERCENTAGE MONTHLY EGG PRODUCTION FOR 2,375 BARRED ROCK PULLETS HATCHED IN MARCH, APRIL AND MAY.

Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	25.79	44.04	43.94	40.71	38.72	41.39	53.29	57.06	56.98	51.96	46.23	48.46	.....	.....	166.84
April . . . . .	.....	17.79	36.44	43.25	39.79	45.90	57.06	61.25	56.13	53.12	48.48	46.43	39.22	.....	165.75
May . . . . .	.....	.....	12.17	30.46	32.36	38.69	48.44	53.94	56.61	50.67	49.09	45.98	43.24	31.17	149.90

TABLE No. 3. AVERAGE PERCENTAGE MONTHLY EGG PRODUCTION FOR 1,312 WHITE LEGHORN PULLETS HATCHED IN MARCH, APRIL AND MAY.

Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	20.80	40.48	35.81	35.43	35.59	40.34	47.93	43.66	54.43	55.62	45.19	40.15	.....	.....	150.67
April . . . . .	.....	14.68	42.17	38.05	35.86	40.42	46.41	44.63	59.90	56.22	46.14	39.48	30.97	.....	150.52
May . . . . .	.....	.....	18.66	37.32	44.64	47.12	52.59	51.97	61.66	54.65	46.77	44.52	42.67	26.65	160.96

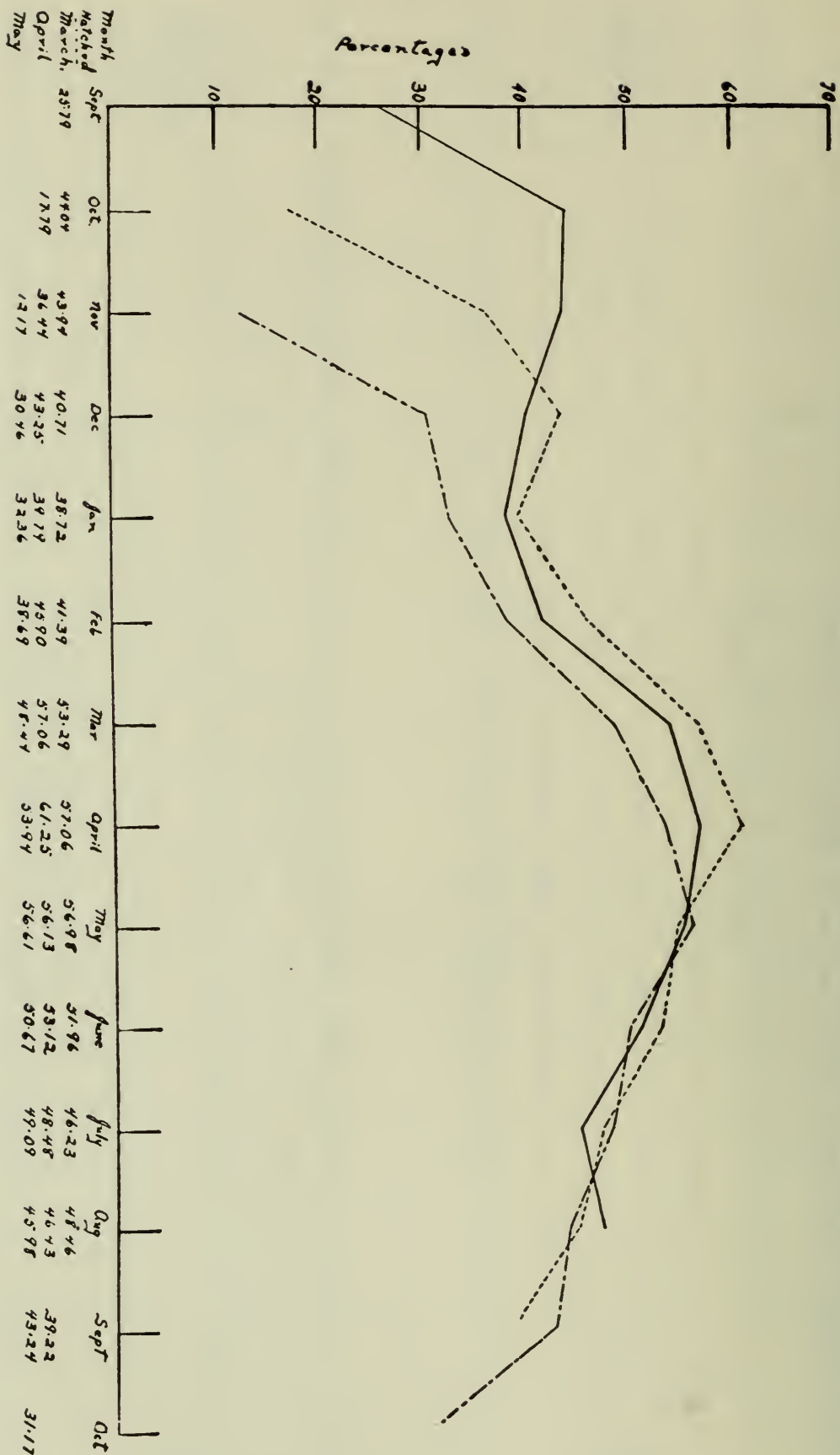
In the following tables is given the average monthly egg production per bird for three groups of Barred Plymouth Rocks and three groups of Single Comb White Leghorns hatched in March, April and May.

TABLE No. 4. AVERAGE MONTHLY EGG PRODUCTION PER HEN FOR 2,375 BARRED ROCK PULLETS HATCHED IN MARCH, APRIL AND MAY.

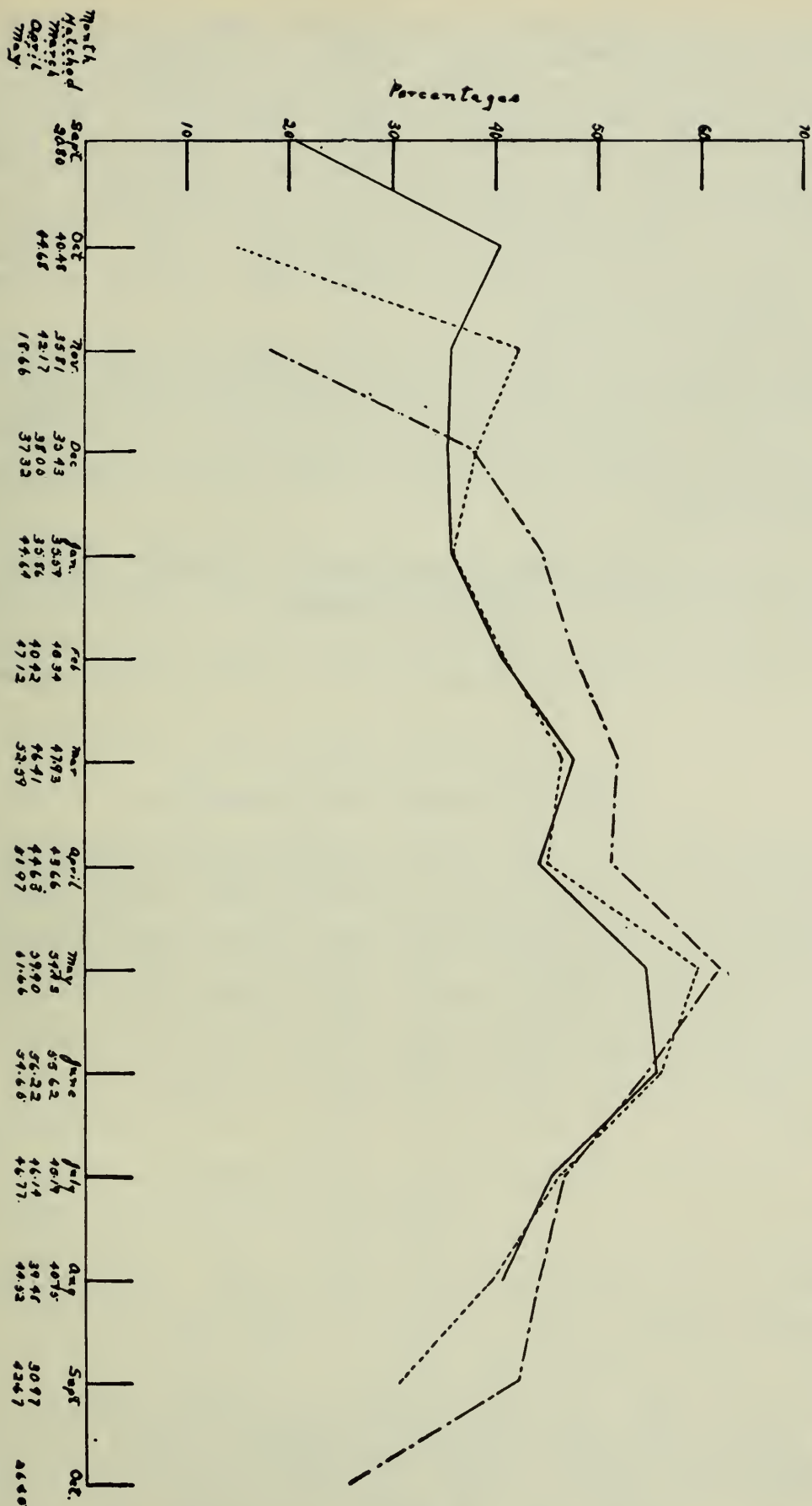
Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	7.71	13.64	13.17	12.60	12.00	11.58	16.50	17.11	17.65	15.57	14.31	15.02			166.84
April		5.51	10.93	13.42	12.36	12.86	17.70	18.37	17.40	16.00	15.03	14.40	11.77		165.75
May			3.65	9.44	10.03	10.83	15.07	16.17	17.50	15.20	15.22	14.25	12.97	9.66	149.90

TABLE No. 5. AVERAGE MONTHLY EGG PRODUCTION FOR 1,312 WHITE LEGHORN PULLETS HATCHED IN MARCH, APRIL AND MAY.

Month Hatched	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Average Annual Production
March	6.24	12.55	10.74	10.98	11.03	11.29	14.85	13.10	16.77	16.68	14.00	12.44			150.67
April		4.55	12.65	11.79	11.12	11.31	14.39	13.39	18.57	16.99	14.21	12.27	9.28		150.52
May			6.59	11.57	13.84	13.19	16.30	15.29	18.85	16.00	14.50	13.80	12.80	8.26	160.96



Graph 1. Percentage Egg Production by months of three groups of Barred Rock Pullets hatched during the months of March, April and May.



Graph 2. Percentage of Egg Production by months of three groups of White Leghorn Pullets hatched during the months of March, April and May.

In the foregoing tables it will be noted that the average annual production is practically the same for different dates of hatching. It would therefore appear that so far as total production is concerned there is little to be gained by early hatching. If, however, the reader will compare the production figures for the different months, and the different groups, he will find that the early hatched birds produced a moderately large number of eggs in the Fall when prices were high, before the later hatched birds got started. This difference is very graphically shown in Graphs 1 and 2. There is the further advantage in early hatching, especially with early March hatched chicks, in that the cockerels can often be brought to broiler weight while the price for broilers is still good and the cockerels can be marketed, thus giving the pullets a better chance to develop.

Viewing the matter from the purely economic standpoint of egg production, it is interesting to compare the values of the eggs produced by birds hatched during different periods on the basis of current market prices for eggs at country points. Below is given the average monthly price of eggs per dozen on the Grade A Large, or its equivalent, at country points in Ontario for the seven years, January 1st, 1928, to December 1st, 1934.

TABLE No. 6.—PAYING PRICE FOR GRADE "A LARGE" (EXTRAS) AT COUNTRY POINTS

	1928	1929	1930	1931	1932	1933	1934
January	43.0	40.5	53.5	29.0	20.0	21.4	25.0
February	39.0	43.0	45.0	26.0	21.6	18.0	33.2
March	35.0	35.0	30.0	21.6	18.5	16.1	23.4
April	29.5	27.0	28.0	19.0	13.6	13.5	16.5
May	31.0	28.0	29.5	16.0	13.5	13.0	17.0
June	32.0	28.0	35.0	16.5	15.4	14.8	18.1
July	35.0	29.0	28.0	17.0	16.4	15.9	18.7
August	39.0	40.0	30.0	22.0	18.8	16.8	19.8
September	41.5	43.0	33.0	23.5	23.2	21.2	25.2
October	47.0	47.0	40.0	36.0	29.4	30.1	31.5
November	57.0	56.5	51.0	43.0	39.1	39.0	35.4
December	55.0	57.0	48.0	36.0	30.7	30.7	28.8
Average price per doz....	40.6	39.5	38.4	24.6	21.7	20.9	24.4

On the basis of the above prices and the average production figures as given in Tables 4 and 5 it will be found that there is considerable variation in the total value of the eggs laid by the different groups. The production figures would indicate that there would be little difference in the value of the eggs produced by either breed hatched in March or April. The great difference is noticeable when comparing May hatched birds with either of the other groups. The March and April hatched Barred Rock pullets laid more eggs during the year and also laid more heavily during the

months when eggs were a high price than did those hatched in May. On the contrary, the May hatched White Leghorns laid more eggs for the year, and as many if not more, during the months of November to February, than did the March and April hatched groups. It is difficult to figure the exact differences from the above tables as the grade of these eggs are not available and much would depend on how the eggs graded. The earlier hatched pullets would be expected to lay larger eggs earlier in the year and consequently their eggs would grade better and so would bring a higher price than would the eggs laid by the later hatched birds.

The above table also shows clearly the decided drop in egg prices in 1932 and 1933 compared with the four previous years during which prices were fairly stationary. A study of the table, will, however, show that the relative values per month in 1932 and 1933, as compared with the previous four years, are practically the same. The prices gradually rise from May until they reach a peak in November and December and they fall to the year's low in April and May.

In presenting the foregoing figures it is not the intention that they be interpreted as possibilities of the two breeds, as the strain or selection work might show as great difference between strains of the same breed. These figures are given in the hope that they may suggest, particularly to the specialized poultryman, the necessity of carefully recording his daily, weekly, and monthly records of production costs and profits. The keeping of poultry as a specialized business means, if success is to be obtained, a daily or at least a weekly record of the loss and profit. Success or failure depends much upon these accounts. Yearly statements usually show losses, leaks, etc., too late.

FALL CARE OF BREEDING HENS

Birds to be considered as next year's breeders may be put out on a good grass range, or where there is a good patch of rape. The colony houses that were used for raising chickens may be moved to this range. The hens then are transferred to these houses, about fifty hens to a house, each house having a floor space of eight feet by twelve feet. This provides roosting space only. No mash feed is given nor any milk or animal protein. The birds are given a ration of whole grain, water and green feed, and allowed to range as they please. In a few days egg production ceases, the birds start to moult, the yellow returns to their legs and beaks, and they have a real holiday. There are enough birds in a house to keep it moderately comfortable on rainy or cold days, though it is possible that few hens may be lost owing to a lack of physical fitness.

Our method is to allow these hens to remain on range for at least two months, after which they are placed in the breeding pens.

One usually has some very old, high-class breeding hens that have demonstrated their worth as breeders. Old hens often are late in starting to lay and frequently the first three or four eggs laid after a period of rest are infertile. Because it is desirable to secure as many chicks as possible during March and April from these selected birds, it is our practice to use a little artificial light on them so that they may be laying a high percentage of eggs during February. They are fed the same ration as that fed to the pullets, using milk as the protein source, and care being taken that they have plenty of clover and bone meal. The birds are allowed out of doors when the weather permits and receive what direct sunshine is available. They also have two per cent of cod liver oil added to their mash mixture.

The Department has used the above plan with satisfactory results for the past eight years on upwards of a thousand breeders.

Hatchability of eggs is an inherited factor that is influenced by environment. Some hens' eggs are low in hatchability; others are high in hatchability. The above methods of feeding and management have given good results regardless of the number of eggs the hen may have laid during her pullet year.

FALL CARE OF PULLETS

After moving pullets in off the range to their Winter quarters, one should continue to feed the same ration as used on the range, for two or three weeks. Give the birds all the succulent green feed they will consume. If succulent material such as cabbage, rape, roots, lawn clippings or sprouted grains are not available, then the addition of a cup of molasses to each pail of drinking water would help. The sudden change from open range to confinement and all dry feed, tends to cause constipation, which condition conduces to the more ready development of disease. Do not be in too much of a hurry to push the pullets into heavy egg production. Give the birds a chance to get adjusted to the change of environment and its effect upon their physical condition. Do not overcrowd.

EXPERIMENTAL STUDIES OF THE PRODUCTION AND HATCHABILITY OF HEN'S EGGS

Many thousands of dollars are lost annually because of poor hatches. Even in our modern types of incubators, with their efficient control for the regulation of temperature, ventilation and moisture, about forty per cent of the eggs set each Spring fail to hatch. Poor hatches may be attributed to many causes. Too often, however, such poor hatches are blamed on the incubator when in reality the fault lies elsewhere. It can be truthfully stated that the majority of incubators in use at the present time will give reasonably good results, provided the eggs set are from a well managed flock and provided the operator is faithful and accurate in his or her care of the machine.

Good management of the breeding stock is a very important factor in securing good hatches. This involves the selection of the birds used, not only as to their pedigrees and type, but also as to their health and vigour. Two other factors, the importance of which in reference to their influence on hatchability are not so generally recognized, are the ration fed to the breeders and the amount of sunshine to which these breeders are given access. It is generally recognized by poultrymen that eggs set during the early part of the hatching season from birds in confinement do not hatch as well as do eggs produced later in the season by birds allowed outdoors and given plenty of sunshine. It was believed by the authors that the source of animal protein has a definite bearing on the value of a ration used for the production of hatching eggs, and it was desired to ascertain more exactly, if possible, the role of sunshine and of its commonly used substitutes in this respect.

In order to gather data on the effect of these factors, viz., the source of animal protein in the ration and sunshine and its substitutes, the experimental trials here reported were conducted. It was hoped that by such trials some measure of the actual effect of these proteins and of sunshine and its substitutes on hatchability would be secured.

The general plan of the experiment was to study the influence of such animal proteins as milk, fish meal, meat meal and tankage as they might affect hatchability and egg production. These materials were fed both singly and in combination as the sole source of animal protein in the rations, with and without cod liver oil. The experiments consider two main points:

1. The effect of certain animal proteins on the hatchability of hens' eggs;
2. The effect of the amount and quality of sunshine on the hatchability of hen's eggs.

Genetics is also a factor in hatchability and may be of equal importance with animal proteins and the amount and quality of sunshine. This factor is, however, not taken into consideration in the discussion of the results here reported. The birds used in the experimental trial were all of known ancestry and come from the general pedigree pens of the Department. Their ancestry was known for ten years or more, together with their record of performance. This information may help materially in the final study of the problem.

The incubator used was a six thousand egg Petersime machine, which made it possible to set all eggs daily over the entire period. This was done and so insured that all eggs would be under the same environmental conditions during incubation.

Twenty Barred Rock pullets and one male as nearly similar in age and breeding as possible were used in each pen. The males were moved from pen to pen daily in rotation. The results from all pullets used in the experiments conducted by this Department suggest that April hatched Barred Rocks give a lower hatch than birds hatched in February and March. Pullets were used in preference to hens because their eggs were likely to be a little more difficult to hatch, other things being equal.

In case of the death of a bird it was immediately replaced by a bird of similar breeding so that the pens were constantly up to strength.

The individual pens were twelve feet wide and twelve feet deep. There were two glass windows three feet by three feet six inches in each pen, as well as two movable screens which could be opened on days when the weather permitted. The screens were twenty inches square. One was covered with cheesecloth and the other with cel-o-glass. The trap-nests, drinking fountains, pens and feed hoppers were the same size in each pen. There should be little or no difference between the pens.

THE METHOD OF FEEDING AND MANAGEMENT

In view of the many factors that may affect both production and hatchability, a system of feeding and management was developed to control as many of these as possible. With this in mind, on a measurable basis, the following feed schedule was followed:

A.M.—A light feed of grain was scattered in the litter;

Noon—A portion of the mash for each pen was fed moistened;
The cod liver oil was fed in this mash daily.

P.M.—A heavy feed of grain was fed in troughs.

N.B.—No artificial lights were used.

The mash for each pen was fed in hoppers and was available for the birds to eat throughout the entire day.

All birds were confined to the pens for the entire eleven months.

RATIONS FOR EXPERIMENTAL HENS

Basal Mash to all pens:
 700 lbs. corn chop
 500 " wheat shorts
 300 " oat chop
 10% alfalfa meal
 2½% bone meal
 2% salt

Whole Grain Mixture:
 50 lbs. cracked yellow corn
 50 " wheat

Daily amount to each pen:
 A.M.—½ lb. in the litter
 P.M.—2 " in the hopper

To the dry mash, kept in front of the birds all the time, was added the following:

Pen.	Amount and kind of Protein	Other Additions
2	10% B.P. (Buttermilk Powder)	U.V.L. (Irradiation)
4	10% B.P.	Cod Liver Oil
6	5% B.P. + 7½% Fish Meal	
8	5% B.P. + 7½% Fish Meal	Cod Liver Oil
10	5% B.P. + 10% Meat Meal	Cod Liver Oil
12	5% B.P. + 10% Tankage	Cod Liver Oil
18	20% Meat Meal	Cod Liver Oil
20	10% B.P.	
22	20% Meat Meal	
24	20% Tankage	
26	15% Fish Meal	
28	15% Fish Meal	Cod Liver Oil
30	20% Tankage	Cod Liver Oil
32	37% B.P.	Cod Liver Oil

N.B.—U.V.L. (Ultra Violet Light) one-half hour of irradiation daily except Sunday.

C.L.O. (Cod Liver Oil) 20 c.c. daily to each pen, in moist mash.

In addition to the dry mash the birds had free access to oyster shell, grit and water at all times. The weighed quantity of grain, 2½ lbs. per pen per day, was fed on an assumed ratio of 50-50 mash to grain consumption. Any variation in food consumption was thus measured by the amount of dry mash and oyster shell eaten.

The protein supplements, with the exception of buttermilk powder, were added to the basal mash on an equivalent basis. Some quantities of the basal mash were weighed out weekly into separate containers and the different animal proteins added to the various mixtures.

A chemical analysis of each individual source of protein was determined. An equivalent quantity of fish meal, meat meal and tankage was fed on the basis of their chemical analysis, with the exception of buttermilk powder, of which one-half of the quantity by weight was used.

The feeding trials included two pens for which buttermilk powder constituted the protein supplement in the mash. For the one pen 10% was added to the mash, while for the other 37% was added, this latter being enough to equal the amount of animal protein given to the pens fed fish meal and meat meal.

COMPOSITION OF THE RATIONS

In Table 7 is shown the percentage composition of representative samples of each of the protein supplements used in these experiments. Repeated analysis of different samples of the same protein concentrate, showed that the composition varied

within fairly wide limits. For example, the buttermilk powder consignments analyzed varied in crude protein content from 29% to 35% it was, therefore, necessary to make protein determinations on each new batch of feed and to increase or decrease the amount of the protein supplement in the ration, so that the total protein would be kept approximately the same throughout the entire experiment. The percentage composition of the mash feed to each pen is given in Table 8 and was calculated from the percentage composition of the ingredients of the mash (see Table 7). To study the effect of adding cod liver oil or ultra violet irradiation to the buttermilk powder rations, the total protein of these rations was kept approximately the same at 13.5% (i.e., Pens 2, 4 and 20). The total protein content of the rations, planned to compare the different protein supplements both with and without cod liver oil (i.e., Pens 18, 22, 24, 26, 28, 30, and 32), was approximately 21%. Where comparing the nutritional value of the combinations of these protein supplements (i.e., Pens 6, 8, 10 and 12) the total protein of the rations was approximately 18%.

TABLE No. 7.—PERCENTAGE COMPOSITION OF PROTEIN SUPPLEMENTS

	Meat Meal	Tankage	Fish Meal	Buttermilk Powder	Semi-Solid Buttermilk	Basal Mash
Moisture	3.84	5.89	5.90	7.62	71.25	9.82
Crude Protein (Nx6.25)	55.90	56.70	75.77	34.80	9.90	12.34
Ether Extract	14.58	10.91	3.86	5.31	1.65	4.78
Crude Fibre	1.22	1.79	.23	.....	.....	7.59
Lactose . . . . .	.....	.....	.....	37.91	10.90	.....
Lactic Acid . . . . .	.....	.....	.....	5.82	4.60	.....
Total Ash	10.51	20.28	17.63	8.47	1.90	4.95

TABLE No. 8.—PERCENTAGE COMPOSITION OF THE MASH

Pen	Ration	Crude Protein (Nx6.25)	Ether Extract	Crude Fibre	Total Ash
2	B.P. + Irradiation	13.5	4.7	6.8	5.3
4	10% B.P. + C.L.O.	13.5	6.7	6.7	5.2
20	10% B.P.	13.6	4.7	6.8	5.3
32	37% B.P. + C.L.O.	20.6	6.9	4.6	6.2
18	20% Meat Meal + C.L.O.	20.8	8.7	6.1	7.8
28	15% Fish Meal + C.L.O.	21.3	6.4	6.3	6.7
30	20% Tankage + C.L.O.	21.1	8.0	6.7	8.1
26	15% Fish Meal	20.6	4.2	5.7	6.4
22	20% Meat Meal	21.0	6.7	6.3	7.9
24	20% Tankage	21.2	6.0	6.4	8.0
10	5% B.P. + 10% Meat Meal + C.L.O.	17.6	7.5	6.4	5.5
8	5% B.P. + 7½% Fish Meal + C.L.O.	17.9	6.6	6.5	6.0
12	5% B.P. + 10% Tankage + C.L.O...	17.6	7.2	6.5	6.5
6	5% B.P. + 7½% Fish Meal	18.2	4.7	6.7	6.2

The data referring to the hatchability of eggs is based only upon the fertile eggs. All the eggs candled out as infertiles during incubation were broken for examination. A small percentage of the eggs removed as infertile, at the time of candling, contained a dead germ of early development.

EMBRYO MORTALITY

The Distribution and Causes of Dead Germs

There appears to be three distinct peaks in embryo mortality during the incubation period, as shown in Fig. 1. The first peak appears between the second and fifth days and represents the dead germs removed on a first test, where it is made at the end of the first week. The second peak occurs from the ninth to the fourteenth days and the dead embryo would be removed at the second test, on the seventeenth or eighteenth days. The third peak, occurring after the eighteenth day, would constitute the fully formed dead-in-shell, at the end of the hatch.

The first two mortality peaks are quite definitely associated with the bird's nutrition and its freedom from disease, as is very clearly shown in Figs. 1, 3, 4, and 6. The third or last peak is not affected to the same extent by these factors. Seasonal variation is most marked, as between Winter and Summer, possibly due to the low antirachitic value of Winter sunshine and an insufficient supply of cod liver oil, or other D vitamin carriers.

DISTRIBUTION OF EMBRYONIC MORTALITY

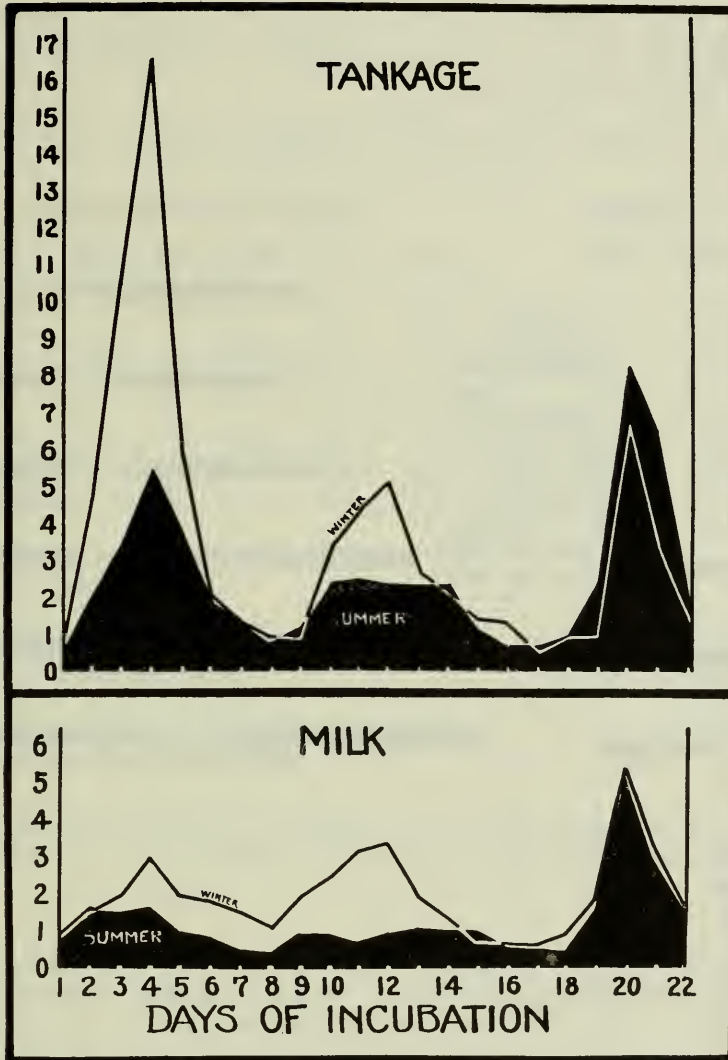


Fig. 1. Showing the distribution of embryonic mortality throughout the incubation period under both Winter and Summer conditions on two animal protein sources in the diet—top, tankage; bottom, milk. The birds were confined but received the available sunshine directly through wire-screened openings on the front of the pens.

In Fig. 1 is shown the hatchability results from tankage as a source of animal protein of low Winter value, and from milk as a source of high hatching quality.

The three mortality peaks are quite marked for tankage in the Winter graph. However, under Summer conditions, with increasing amounts of sunshine, these peaks were considerably reduced, as shown in the Summer graph, or the first peak was reduced from almost seventeen per cent to about five per cent. This same result is evident in the tests of milk, as shown in Fig. 6, but not to so marked an extent. In these latter the Winter peaks of mortality were not so high; in other words, this protein was more efficient in producing hatchable eggs in Winter than was tankage. It will of course be noted that there is at the same time considerable variation in the efficiency of the other proteins studied as affecting hatchability.

Likewise in Fig. 6, on the right hand side, is shown the results of the effect of a disease outbreak such as Laryngotracheitis. While not sufficiently severe to cause any mortality, it nevertheless very seriously lowered hatchability, as will be seen from a comparison with the results of a three year average on the same diets, as shown on the left hand side of the same figure. Similar results are shown in Figs. 3, 4 and 5.

SUNSHINE AS A FACTOR IN HATCHABILITY

The role of direct sunshine in the welfare of man, plants and animals is recognized, but perhaps not too well understood. Its influence on hatchability has been a matter of study for some time.

The amount of sunshine differs greatly between February and July.

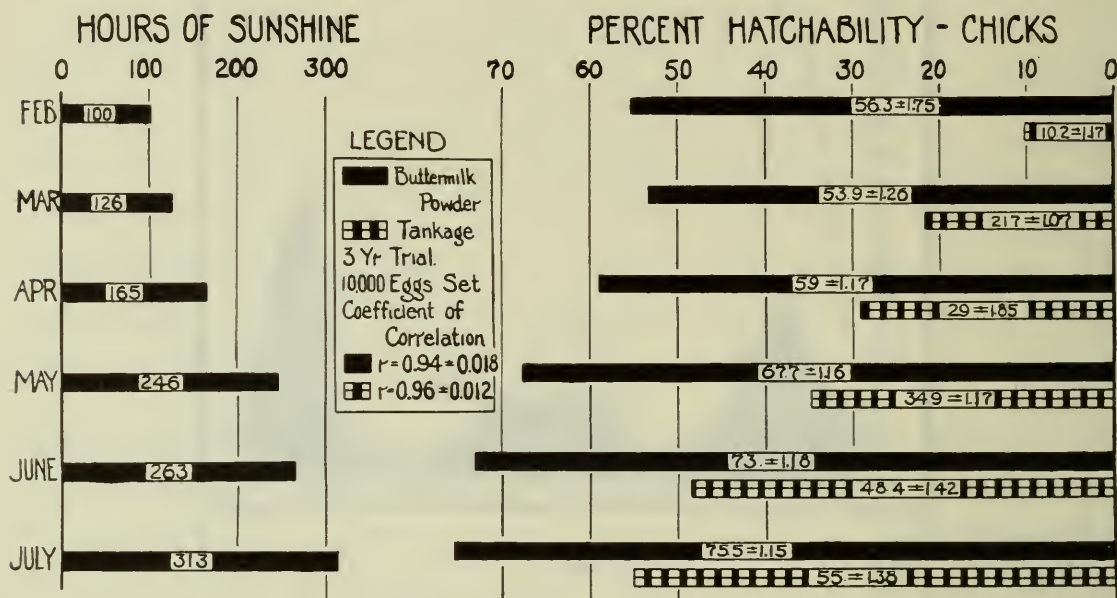


Fig. 2. Showing the influence of the amount of sunshine on the per cent of hatchability when two sources of animal protein, each differing widely in its feeding value, are used in the diet.

The antirachitic effect of sunshine during the months of April, May, June, July and August is approximately eight times as great as that of November and December (Tisdall and Brown). The beneficial results on hatchability from increased amounts of sunshine are clearly shown in Fig. 2, where two sources of animal protein, each differing widely in its feeding value, were used in the diet. The birds were confined to their pens, receiving the available sunshine through two openings twenty inches square. These openings were screened with cotton at night and on stormy days.

The results are based on a three year trial with over ten thousand eggs.

The high value of Summer sunshine naturally raises the question of a good substitute to compensate for the lack of it during the late Fall and Winter months; or could June and July hatches be duplicated in January, February and March with a suitable substitute?

THE INFLUENCE OF SUNSHINE ON EMBRYONIC MORTALITY

It is of importance to measure the influence of the amount of sunshine on the per cent and distribution of deaths during the twenty-one days required for incubation. The upper curve (Winter) represents the mortality curve in per cent of deaths of the fertile eggs set and is plotted against time in days of incubation, Fig. 1. The solid black area (Summer) represents the mortality rate in per cent of fertile eggs set. The Winter season includes the months of February, March and April, while the Summer is for that of May, June and July.

Tankage, (Fig. 1) has a low efficiency when used alone in the diet in the Winter months. There is a severe peak in mortality on the fourth day, reaching about seventeen per cent of the fertile eggs set. It will be seen that the peak is greatly reduced in the Summer which naturally results in much higher hatchability. In Winter 15.1 per cent of the fertile eggs contained embryos which died on the fourth or fifth days in an anaemic condition. During the Summer the occurrence of anaemic embryos in the eggs from this diet declined to a 1.5 per cent average with few, if any, dying during the month of July from this abnormal condition.

Where milk (buttermilk powder) is used alone in the diet (Fig. 6) the increase in hatching quality of the eggs is due to a straightening out of the curve representing the first and second week mortality rate. The mid-incubation peak in the Winter mortality curve is reduced more through the beneficial action of increased amounts of direct sunshine than in the first week peak, occurring on the fourth day. Neither the diet fed the hen nor the season of the year appear to have any influence on the death rate taking place on the twentieth day. Malpositions play a part in this excessive mortality during artificial incubation but they will not be discussed at this point.

TABLE No. 9.—SHOWING THE INFLUENCE OF THE AMOUNT AND QUALITY OF SUNSHINE ON THE PERCENTAGE HATCHABILITY

Ration	Feb.	Mar.	April	May	June	July
Buttermilk Powder	56.3	56.1	59.0	71.7	72.8	74.8
Meat Meal	51.2	47.4	44.6	55.0	68.6	63.6
Tankage	10.2	21.7	29.0	34.9	48.4	55.0

The beneficial influence of the amount and quality of sunshine is clearly shown in Table 9. With over two hundred hours of sunshine the hatch is increased 12.7 per cent, 10.4 per cent and 5.9 per cent for buttermilk powder, meat meal and tankage. The hatching quality of the eggs gathered in May, June and July has, for all three rations already referred to, been greatly improved over that for the months of February, March and April.

The following tables contain a summary of the three years' results for several rations differing mainly in the kind of animal protein used. In each table are given the results for a single animal protein alone and in combination with cod liver oil, and with the oil and another protein. The accompanying graphic illustrations present a picture of the embryonic mortality during the incubation period on some of these same feed combinations.

TABLE No. 10—MEAT MEAL—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar.	April	May	June	July	* Egg Production	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Meat Meal ...	51.2	47.4	44.6	55.0	68.6	63.6	138.4	7.05	80.9
Meat Meal and C.L.O. ...	69.2	67.4	59.9	71.9	70.6	72.0	164.2	5.95	77.5
Meat Meal, Buttermilk Powder and C. L. O.....	76.9	75.2	60.0	59.6	66.5	74.5	165.6	5.87	81.0

* Eleven months only.

A combination of buttermilk powder, meat meal and cod liver oil was a more satisfactory ration than either meat meal or meat meal and cod liver oil. When buttermilk powder and cod liver oil were added to meat meal, the egg production was increased thirty-seven eggs per hen, the hatchability of the eggs was much higher

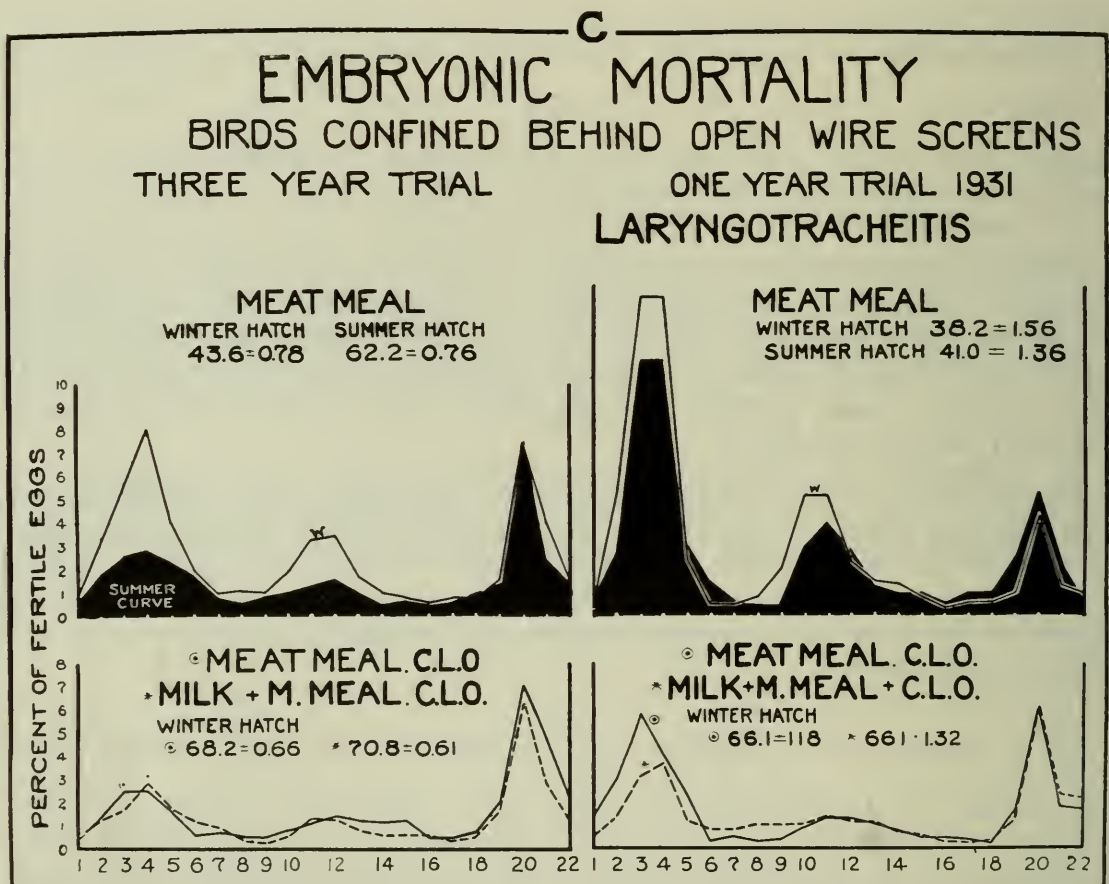


Fig. 3. Showing the effectiveness of cod liver oil when added to meat meal in promoting Winter hatchability. The milk, meat meal and cod liver oil combination gave a satisfactory Winter hatch. On the right hand side of the chart, the influence of the disease factor is shown, where the source of animal protein in the ration was meat meal.

for the Winter months and over one pound of feed was saved for every dozen of eggs laid. The beneficial influence of cod liver oil when added to meat meal is shown by the increase in the number of eggs produced, the pounds of feed required to produce one dozen eggs, and the hatchability of the eggs for all the months but more especially for those of the Winter season. It is interesting to note that after two hundred hours of sunshine were available, the meat meal pen produced a much higher hatchability. A combination of animal protein supplements fed with cod liver oil gave more satisfactory results than did a single animal protein supplement with cod liver oil.

TABLE No. 11—FISH MEAL—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar.	April	May	June	July	* Egg Produc- tion	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Fish Meal	57.4	59.3	53.0	56.6	69.4	71.8	165.4	6.18	85.1
Fish Meal and C.L.O. ..	64.3	60.2	50.3	63.6	66.4	67.5	177.8	5.64	83.6
Fish Meal, Buttermilk Powder and C. L. O.	79.2	74.0	58.8	63.3	67.9	67.9	166.6	5.91	82.0

* Eleven months only.

When cod liver oil was added to fish meal the egg production was increased one dozen eggs per hen for eleven months and it required less feed to produce a dozen eggs. Apparently the vitamin content, as supplemented by cod liver oil, has some influence on the egg production. Cod liver oil did not improve the hatch for February, March and April when added to fish meal to the same extent that it did when added to buttermilk powder or meat meal. With buttermilk powder and cod liver oil added to the fish meal the hatch was greatly improved for February and March and was somewhat higher for April. The egg production was eleven eggs less per hen where buttermilk powder was added to the fish meal and cod liver oil and it required slightly more feed to produce a dozen eggs.

While the egg production was down eleven eggs on the average for buttermilk powder, fish meal and cod liver oil, as compared with fish meal and cod liver oil, the hatchability of the eggs was very much in favour of the combination ration.

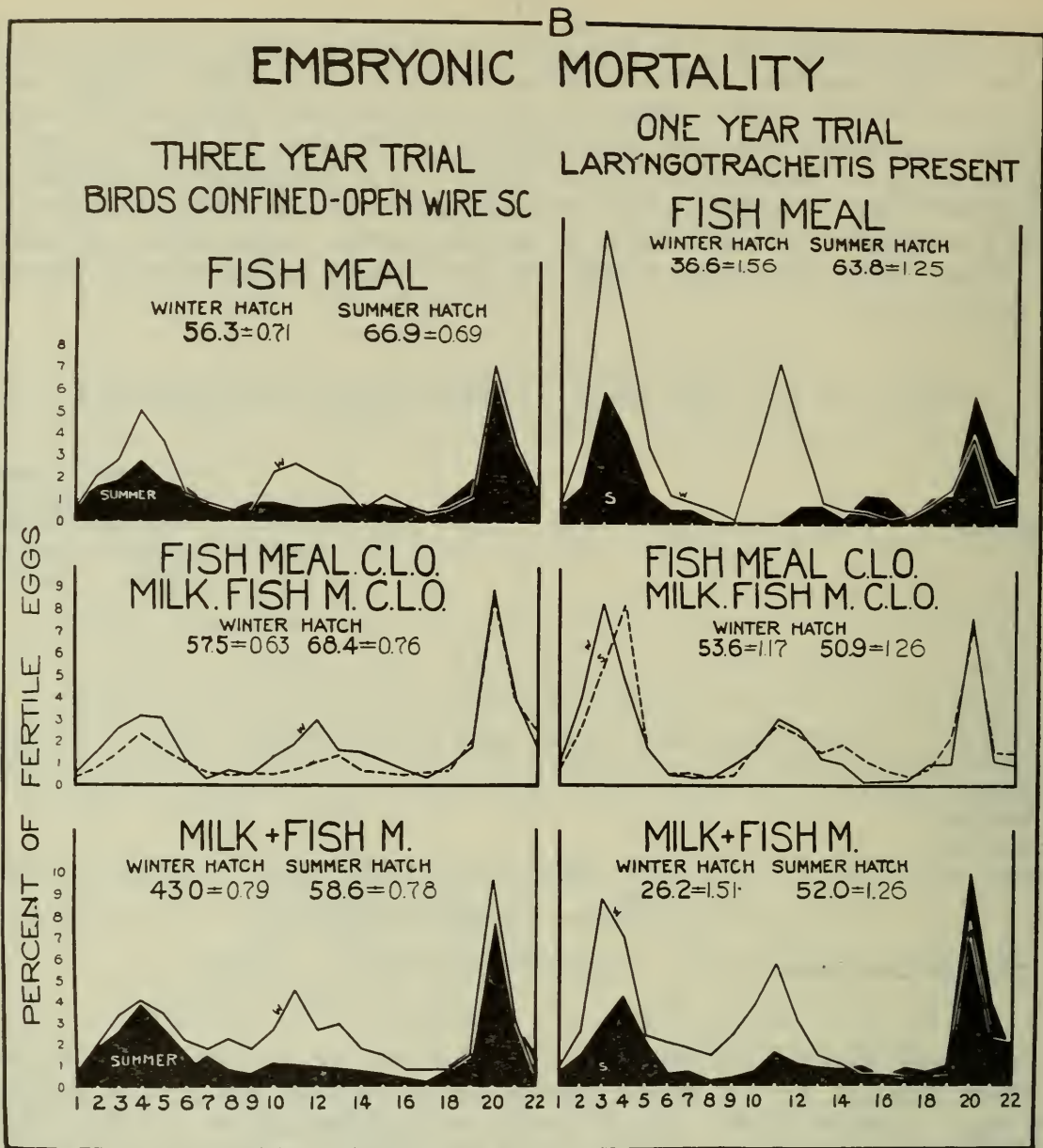


Fig. 4. On the right the effect of an infection on hatchability and embryonic mortality during the 1931 season is shown for the sake of comparison. On the upper left the failure of cod liver oil to improve the Winter hatch, when fish meal was the source of animal protein, is shown. Milk and fish meal when fed without cod liver oil gave unsatisfactory results. The value of milk on hatchability is indicated when the results for milk, fish meal and cod liver oil are compared with that of fish meal and cod liver oil.

TABLE 12.—TANKAGE—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar.	April	May	June	July	* Egg Production	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Tankage	10.2	21.7	29.0	34.9	48.4	55.0	126.6	7.44	78.5
Tankage and C. L. O.	27.9	41.2	28.7	39.4	57.8	57.6	157.2	6.03	79.3
Tankage, Buttermilk Powder and C. L. O.	72.0	58.6	58.7	42.7	55.6	60.4	151.0	6.41	80.7

* Eleven months only.

Tankage gave a low egg production, eggs of poor hatchability, and it required over thirty per cent more feed to produce a dozen eggs than where fish scrap was used. Cod liver oil added to tankage increased egg production thirty-one eggs per hen with almost one and one-half pounds of feed less required to produce one dozen eggs. The hatching quality of the eggs was improved for all months but was still unsatisfactory. A combination of buttermilk powder, cod liver oil and tankage gave a fair hatch, but did not compare favourably with the results from the other combination rations studied. Not only did cod liver oil improve the hatchability of the eggs, when added to tankage, but it also materially increased the egg production.

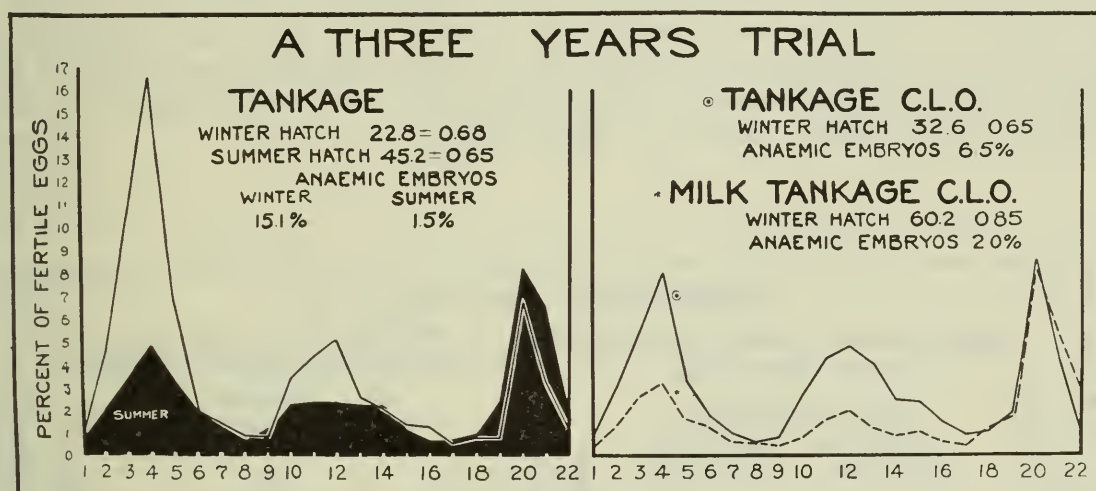


Fig. 5. The value of milk in the ration fed the breeders is shown graphically in the above chart.

TABLE No. 13—MILK—PERCENTAGE HATCHABILITY

Ration	Feb.	Mar.	April	May	June	July	* Egg Production	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
10% Butter-milk Powder	56.3	56.1	59.0	71.7	72.8	74.8	143.6	7.05	84.4
10% Butter-milk Powder and C.L.O...	73.4	69.9	60.6	54.8	64.1	65.1	153.5	6.48	82.8
†37% Butter-milk Powder and C.L.O...	75.8	75.7	65.8	74.1	80.0	73.3	153.7	6.07	77.8
§10% Butter-milk Powder & Irradiation	74.1	77.2	71.7	74.0	79.5	77.1	139.8	7.01	81.7

* Eleven months only.

† Two year results.

§ Birds handled every day except Sunday.

With the addition of cod liver oil to buttermilk powder the number of eggs produced was increased, the hatchability was improved considerably for the Winter months, and less feed was required to produce a dozen eggs. Again it may be seen that the amount of vitamin as supplied by cod liver oil, or as activated by irradiation, has not only influenced the hatchability of the eggs but also the egg production. By increasing the amount of buttermilk powder in the diet to thirty-seven per cent there was no increase in the egg production although a little feed was saved. The hatchability, however, was higher for all the months. Irradiation from a Mercury Quartz Lamp would appear to be more efficient in activating the development of the necessary vitamin D than was cod liver oil. The egg production for this pen was low, but in view of the fact that the birds were handled every day except Sunday and were carried in a crate to the top floor of the poultry building to be irradiated, introduced a point of difference when comparing this pen with the other pens. It would seem that when buttermilk powder is fed at the same level as meat meal, fish meal or tankage there is possibly a wastage of this material.

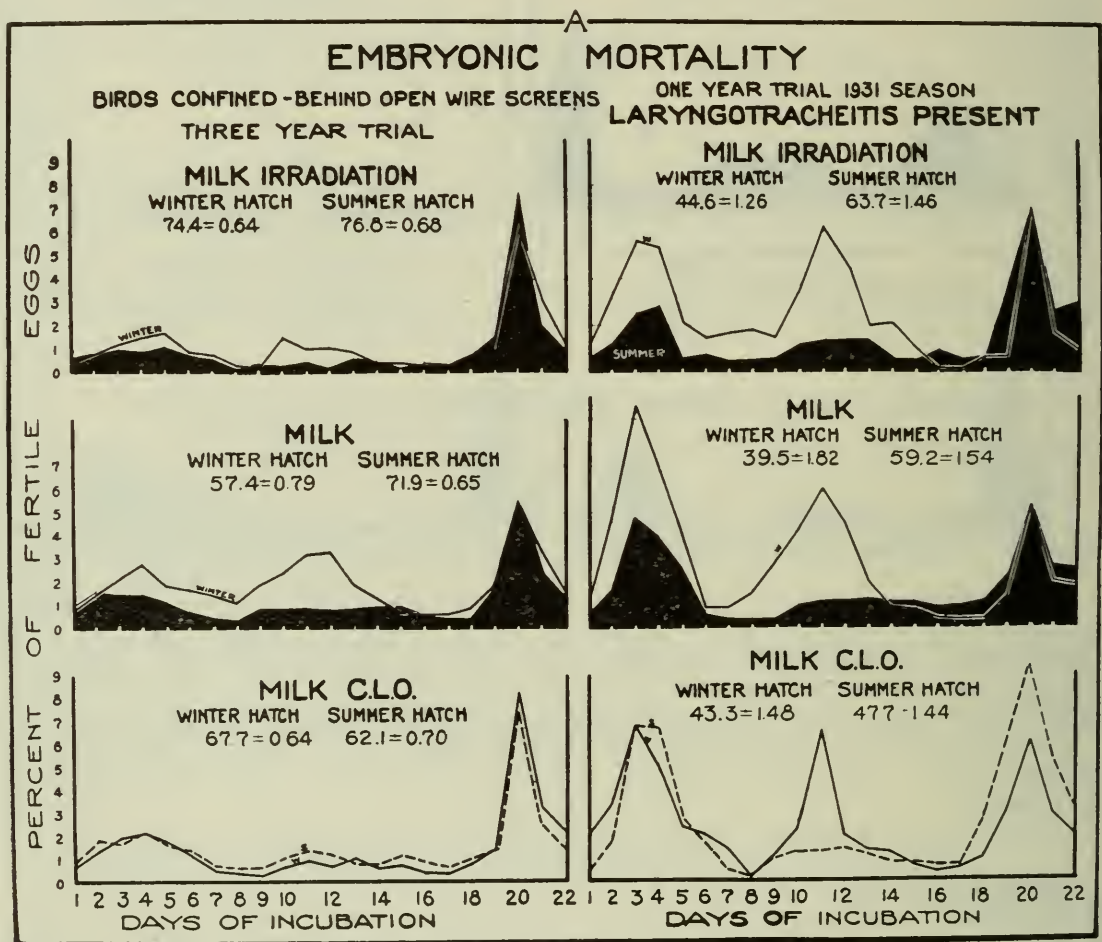


Fig. 6. Comparing the efficiency, when the source of animal protein was the same, of cod liver oil and irradiation of the birds. The effect on hatchability and embryonic mortality of a mild infection of Laryngotracheitis is clearly shown on the right hand side of the chart.

TABLE No. 14.—A COMBINATION OF PROTEINS—PERCENTAGE
HATCHABILITY

Ration	Feb.	Mar.	April	May	June	July	* Egg Produc- tion	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird
Buttermilk Powder and Fish Meal...	58.2	49.1	30.9	42.6	64.5	68.1	141.4	6.78	79.9
Buttermilk Powder, Fish Meal and C.L.O...	79.2	74.0	58.8	63.3	67.9	67.4	166.6	5.91	82.0
Buttermilk Powder, Meat Meal and C.L.O...	76.9	75.2	60.0	59.6	66.5	74.5	165.6	5.87	81.0
Buttermilk Powder, Tankage and C.L.O...	72.0	58.6	58.7	42.7	55.6	60.4	151.0	6.41	80.7

* Eleven months only.

Many are of the opinion that heavy egg production tends to decrease the hatchability of eggs. This does not seem to be the case when the results from the two diets—buttermilk powder, fish meal and cod liver oil, and that from buttermilk powder, meat meal and cod liver oil—are considered. The average production for eleven months was 165 and 166 respectively, while the hatchability averaged over 70 per cent for the months of February, March and April. When tankage was used in place of either fish meal or meat meal, the egg production was down fourteen eggs per bird, more feed was required to produce a dozen eggs, and the hatchability of the eggs was decreased considerably. Twenty-five eggs more per hen were produced when cod liver oil was added to buttermilk powder and fish meal. Hence almost one pound of feed was saved for every twelve eggs produced, and the hatchability of the eggs was greatly increased for the more important hatching months.

A study of the three years' summary shown in Table No. 15 seems to justify the following conclusions:

- (1) When fish meal, buttermilk powder, meat meal and tankage are compared from the standpoint of their feeding value for the production of eggs they rank in the order named.
- (2) The addition of cod liver oil to a single animal protein supplement increased the egg production with all rations tested, but much more so with meat meal and tankage than with buttermilk powder and fish meal.
- (3) A combination of fish meal and buttermilk powder failed to increase either the hatchability of the eggs or the number of eggs produced.

- (4) Cod liver oil when added to a combination of buttermilk powder and fish meal, buttermilk powder and meat meal, or buttermilk powder and tankage, increased both hatchability and egg production.
 - (5) Tankage does not appear to be a desirable source of animal protein when fed as the sole source, but when fed in combination with milk produces moderately good results.
 - (6) The addition of direct sunshine or sunshine substitutes, such as a high grade of cod liver oil or irradiation by a Quartz Mercury Lamp, to the rations used, plus alfalfa meal, was the most important factor in producing eggs of high hatchability.
 - (7) Vitamin D appears to be a very important factor in hatchability. The birds used in these feeding trials did not get the necessary amount of this factor until there were at least two hundred hours of sunlight per month.
 - (8) Buttermilk powder with meat meal or with fish meal, together with cod liver oil, appears to be the most satisfactory combination of supplements used in these trials when hatchability, egg production and the pounds of feed required to produce a dozen eggs are considered.
-

THE EFFECT OF INFECTION ON PRODUCTION

Reference has already been made to the effect of Laryngotracheitis infection on hatchability, Figs. 3, 4, 5 and 6. In Table No. 16 are given the results of such an infection on production. The data for 1930-'31 shows a marked drop in the number of eggs laid over the ten months' period as compared with a similar period in 1931-'32 on the same diets. There is what appears to be an exception to this in the 27½ per cent milk and cod liver oil diet, which was used in 1930-'31 but not in the following year. In this particular case the birds appeared to react less severely to the infection than on any of the other rations. This may have been due to the greater laxative effect of the high milk diet, or the heavier intake of some dietary factor inhibiting the pathogenic action of the infective virus.

TABLE No. 15.—SUMMARY OF THREE YEARS' RESULTS PERCENTAGE HATCHABILITY

RATION	Feb.	Mar.	April	May	June	July	*Egg Produc- tion	Lbs. Feed Required to Produce Dozen Eggs	Average Amount of Feed consumed per Bird	Total Eggs set for three years
Buttermilk Powder, Meat Meal and C.L.O.	76.9	75.2	60.0	59.6	66.5	74.5	165.6	5.87	81.0	5851
Buttermilk Powder, Fish Meal and C.L.O.	79.2	74.0	58.8	63.3	67.9	67.4	166.6	5.91	82.0	5730
Buttermilk Powder and Irradiation	74.1	77.2	71.7	74.0	79.5	77.1	139.8	7.01	81.7	4732
10% Buttermilk Powder and C.L.O.	73.4	69.9	60.6	54.8	64.1	65.4	153.5	6.48	82.8	5430
37% Buttermilk Powder and C.L.O.	75.8	75.7	65.8	74.1	80.0	73.3	153.7	6.07	77.8	3682
Tankage and C.L.O.	72.0	58.6	58.7	42.7	55.6	60.4	151.0	6.41	80.7	5256
Buttermilk Powder, Meat Meal and C.L.O.	69.2	67.4	59.9	71.9	70.6	72.0	164.2	5.95	81.3	6103
Fish Meal and C.L.O.	64.3	60.2	50.3	63.6	66.4	67.5	177.8	5.64	83.6	6575
Fish Meal	57.4	59.3	53.0	56.6	69.4	71.8	165.4	6.18	85.1	5958
Buttermilk Powder	56.3	56.1	59.0	71.7	72.8	74.8	143.6	7.05	84.4	4985
Meat Meal	51.2	47.4	44.6	55.0	68.6	63.6	138.4	7.01	80.9	4683
Buttermilk Powder and Fish Meal	58.2	49.1	30.9	42.6	64.5	68.1	141.4	6.78	79.9	4630
Tankage and C.L.O.	27.9	41.2	28.7	39.4	57.8	57.6	157.2	6.05	79.3	5890
Tankage	10.2	21.7	29.0	34.9	48.4	55.0	126.6	7.44	78.5	4523

* Two years

TABLE No. 16.—EGG PRODUCTION RESULTS FROM VARIOUS PROTEINS
FOR A TWO YEAR PERIOD

An outbreak of Laryngotracheitis in 1930-'31 shows in most cases a decided reaction
on Production.

Ration	Egg Production 10 Months		Lbs. Feed To Produce Dozen Eggs		Average Feed Consumed per Bird	
	1930-'31	1931-'32	1930-'31	1931-'32	1930-'31	1931-'32
Milk, Meat, C.L.O.	127.6	148.5	6.1	5.9	65.7	73.6
Milk, Fish, C.L.O.	126.4	143.2	5.8	5.8	61.2	69.7
Milk, Irradiation	83.1	112.5	7.7	8.3	61.0	78.4
10% Milk	109.5	122.7	7.0	6.8	64.7	71.0
10% Milk, C.L.O.	110.2	141.1	6.8	6.1	62.8	71.5
Meat Meal	114.1	167.9	6.9	5.4	65.9	76.5
Meat Meal, C.L.O.	136.2	153.5	5.8	5.8	66.5	73.8
Fish	140.2	155.4	5.8	5.7	67.8	73.8
Fish, C.L.O.	143.1	156.7	5.4	5.5	64.5	71.5
Milk, Fish	97.4	101.8	7.2	8.0	58.3	68.0
37% Milk, C.L.O.	154.0	.....	5.0	...	65.0	....

SOME FURTHER PROTEIN STUDIES

In 1933 the basal 7-5-3 mash was replaced by the Cafeteria basal developed from the results of a free choice feeding experiment. This mash was made up as follows:

Cafeteria Basal Mash

400 lbs. ground yellow corn
 100 " corn feed or yellow hominy
 200 " white hominy feed
 450 " rolled wheat
 150 " wheat germ
 50 " wheat bran
 100 " rolled barley
 300 " crushed oats
 50 " Banner oat feed, or an equal amount of oat middlings
 20 " ground peas
 20 " soya bean oil meal
 10 " iodized salt
 1 pint cod liver oil to each hundred pounds of mash mixture.
 Oyster shell, bone meal and grit supplied in hoppers.

Using the Cafeteria basal mash, further experiments were carried on with the animal proteins—milk, meat meal and fish meal, separately and in combinations.

The control (Cafeteria) ration, with the animal protein from three different sources, gave a 53.4 per cent hatch for a five month period, Fig. 7. Later, however, when the birds were turned out of doors on a good grass range the hatch improved almost immediately, with an average of 75.6 per cent. From a hatching standpoint the diet appeared to be deficient, such deficiency being supplied by range conditions. Using the same ration, but changing the source of animal protein to milk, a hatch of 74.5 per cent was obtained over a five month period. This is further evidence that milk supplies a factor or factors necessary for successful hatchability and is a

EMBRYONIC MORTALITY ONE YEAR RESULTS CAFETERIA BASAL MASH



Fig. 7. The influence on hatchability of the source of animal protein fed in the ration is clearly shown in the above chart. A comparison of the first and second weeks' mortality rates during incubation appears to be greatly influenced by the diet fed the hen.

reliable source of animal protein to use. Meat meal gave a low hatch of 83.3 per cent, while fish meal gave a hatch of 45.7 per cent. A marked improvement in hatchability under range conditions was shown by these proteins with a 61.1 and 66.4 per cent hatch, respectively.

There is a striking difference in the first and second weeks' death rates during incubation between the milk diet and the others. Excessive embryonic mortality occurred during the first and second weeks of incubation when the diet fed was the control, meat meal or fish meal.

EMBRYONIC MORTALITY LIVER EXTRACT OR MILK - IS A FACTOR IN WINTER HATCHABILITY

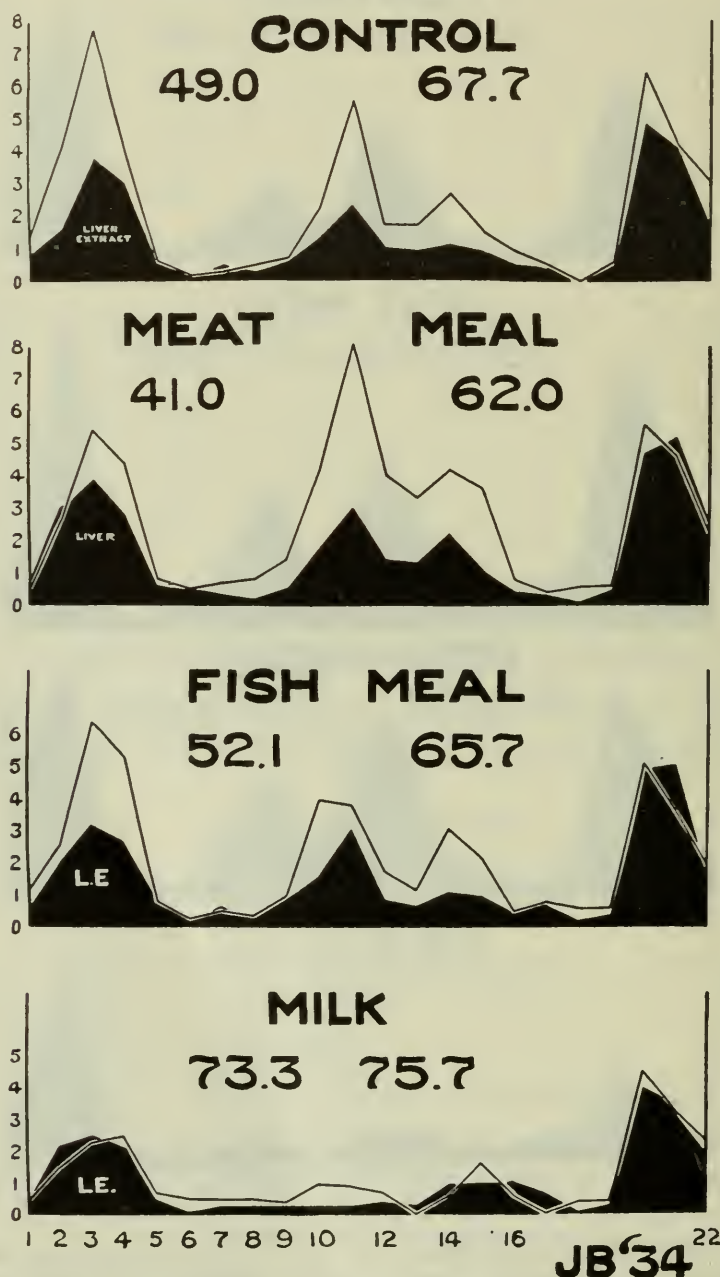


Fig. 8. Showing the results in hatchability and the distribution of embryonic mortality of four different diets with and without the addition of liver extract.

To determine, if possible, the nature of the deficiency of such diets as the control, meat meal and fish meal, liver extract was fed to four pens during the season of 1934. (This latter material was kindly supplied to us by the Connaught Laboratories in Toronto.) It is described by them as follows: "The liver extract, while free from protein nitrogen, did contain nitrogen in peptides or relatively simple compounds." By feeding a small amount of this material to four pens of birds on four different animal protein diets, Fig. 8, the improvement in hatchability is worthy of note with the exception of where milk was the source of animal protein. Those pens receiving the same ration, but having liver extract added, gave satisfactory hatches. Apparently a well marked deficiency from a hatching standpoint in the control, meat meal and fish meal diets, was supplied through the use of this material. It is interesting to compare the results in hatchability of the milk diet with those of the milk and liver diet. Here there was little, if any, significant difference in hatchability, which points strongly to the fact that milk contains the factor or factors necessary for a successful hatch.

Liver extract reduced the first and second weeks' mortality rates during incubation, which were excessive for the control, meat meal and fish meal diets. The source of animal protein fed in the diet appears to have a very definite influence on the per cent and periodicity of deaths during the first eighteen days of incubation.

The results in egg production for 1932-'33 and 1933-'34 on the Cafeteria basal ration, with the various proteins, are shown in Table No. 17. Soya bean oil meal, with and without milk, also crab scrap, were here tested in addition to the other protein sources—milk, fish meal and meat meal—and the production results are given.

TABLE No. 17.—EGG PRODUCTION ON CAFETERIA BASAL MASH PLUS VARIOUS PROTEIN SUPPLEMENTS

Ration	Egg Production		Lbs. Feed To Produce Dozen Eggs		Average Feed Consumed per Bird	
	1932-'33	1933-'34	1932-'33	1933-'34	1932-'33	1933-'34
Cafeteria	170.1	154.1	5.3	5.3	75.1	68.6
Milk	184.4	179.2	5.3	5.2	80.5	75.0
Meat Meal	155.4	142.5	5.5	5.9	71.2	70.5
Fish Meal	182.3	172.4	5.3	5.2	79.5	75.5
Milk and Soya Bean Oil Meal .....	.....	146.0	...	5.9	....	72.0
Soya Bean Oil Meal	153.1	.....	6.1	...	78.1	....
Crab Meal .....	.....	153.5	...	6.2	....	80.0

In view of the rather interesting results in hatchability obtained with the addition of liver extract, as shown in Fig. 8, the egg production results on these same diets are given in Table No. 18.

TABLE No. 18.—EGG PRODUCTION ON CAFETERIA BASAL MASH, PLUS PROTEINS, PLUS LIVER EXTRACT

Ration	Egg Production	Lbs. Feed Consumed to Produce Doz. Eggs	Average Amount Feed Consumed per Bird
Cafeteria and Liver Extract	176.3	5.5	80.6
Meat and Liver Extract	136.6	6.2	71.4
Fish and Liver Extract	187.9	5.2	81.0
Milk and Liver Extract	167.6	5.3	74.3

Some experimental work has been carried on with the four cereal grains—corn, wheat, oats and barley—ground and fed in equal parts. Three different percentage levels of meat meal and fish meal were fed with the cereals. The egg production results are given in Table No. 19.

TABLE No. 19.—GROUND CORN, WHEAT, OATS AND BARLEY, EQUAL PARTS, PLUS ANIMAL PROTEINS AS SHOWN

Ration	Egg Production 1932-'33	Lbs. Feed Consumed to Produce Doz. Eggs	Average Amount Feed Consumed per Bird
7% Meat	143.1	5.8	69.1
10% Meat	151.2	5.9	74.0
19% Meat	178.7	5.1	76.2
5 ¼ % Fish	155.1	5.5	71.2
10% Fish	162.1	5.6	76.3
13% Fish	192.5	4.7	75.6

INCUBATION

The number of eggs needed to produce a chick influences the cost materially. The factors that may influence the hatch are many, including the maturity, age, and breeding of the parent stock and the kind and method feeding. The method of incubation and the type of incubator, including the operator and the room used for incubation are also important factors.

With many factors influencing the results, the cause or causes of failure are difficult to locate and, furthermore, many of these problems are not easy to investigate.

The operator must be painstaking, accurate and methodical in his habits. The management of a large number of setting hens, or the operation of incubators, requires careful attention at regular intervals. Because an incubator is equipped

with a regulator does not mean that the machine will take care of all possible variations in temperature, nor will a heater produce the required units of heat without fuel. The operator must realize that he must do his part.

The room in which the incubators are operated must be well ventilated without producing direct draughts over the machines. The air of the incubator room should be as pure as that in a living room. The less variation in temperature within the room the easier the machine will operate. Any well ventilated, CLEAN cellar or living room will answer.

Machines as a rule run better when set along a wall or in a corner of the room. They should not be set in direct line between an open door and a window. If so placed, unless screened, the lamp may go out or the machine may heat unevenly.

Machines for hatching, varying in capacity from fifty eggs to forty thousand eggs, are now sold. The larger sized machines are gradually replacing the smaller ones. The reasons are clear, in that the larger machines are more economical with labour and fuel. The general trend is towards central hatching stations where one may have eggs hatched at a given price per egg or where one may buy day-old chicks. Many find incubating eggs a good business, while others prefer to go to a hatchery to get their year's supply of chicks without worrying over setting hens or small lamp incubators.

Many makes of incubators have been used at this Department and most of them will give good results if carefully managed. We have seen no one incubator that excelled all others.

Cleaning and Disinfecting Incubators

Cleaning: Thoroughly clean out the machine, scraping from the inside, bottom and sides any adhering dirt. Scrub the interior with hot water to which may be added Gillett's Lye, one tablespoonful to a gallon of water, or one of the common coal tar disinfectants in the recommended strength. When the machine and trays have been thoroughly cleaned in this way, they are ready for disinfection.

Methods of Disinfection

Liquid: Thoroughly saturate the interior of the machine with any liquid disinfectant. The strength of the solution varies with the brand used but one should be careful to see that the solution used is well up to strength.

Gas: In case one does not wish to use a liquid disinfectant, Formaldehyde Gas may be used. Its application is easy and efficient when properly applied. For this use 1 gram Potassium Permanganate crystals to 1.5 cubic centimeters of Commercial Formalin to each cubic foot of space in the machine. To apply, prepare the required quantities of the two drugs for your machine. Place the Potassium Permanganate in a wide, flat, enamelled vessel in the bottom of the machine, as the material will boil and spatter when the Formalin is added. When all is ready, add the required quantity of Formalin solution from an open topped container, as this must be done quickly. As soon as the Formalin is added close up the machine. Leave the machine closed for at least fifteen minutes, after which time open the doors and allow the gas to escape.

For most effective results the machine must be warm and the humidity on the wet bulb thermometer 85 degrees or better 90 degrees. Eggs may be gassed in the machine at any time EXCEPT FROM THE 24TH TO THE 84TH HOURS OF INCUBATION; or in other words, eggs may be gassed during the first 24 hours

after setting. Otherwise they must not be exposed to the above concentration of gas until after they have been in the incubator $3\frac{1}{2}$ days.

Frequency of Disinfection: Machines should be disinfected after each hatch. This, where properly done, prevents any accumulation of infection from one hatch to another. **WE DO NOT ADVISE GASSING CHICKS IN THE INCUBATOR.**

Operating an Incubator

Given a suitable room, the first thing is to see that the machine is thoroughly cleaned. The next operation is to set the machine level. The thermometer must be accurate, and to assure accuracy it should be tested at least once, or better, twice, during the year by having it checked with a clinical thermometer. The temperature given is usually one hundred and three degrees Fahrenheit throughout the hatch. Our experience has been that it is better to take an objective of one hundred and one to one hundred and two degrees and if the temperature creeps up to one hundred and three degrees we have no cause to worry. If operated at a temperature of one hundred and three degrees and the temperature rises to one hundred and four or above either the hatch is small or the chicks hatched are hard to rear. Low temperatures are not so fatal as are high temperatures.

The amount of moisture required in an incubator depends upon the make and the room. Generally it is best to follow the manufacturer's directions.

Cooling and Turning: Eggs incubated in cabinet type incubators are turned by the use of mechanical turners and are not cooled. A forced draft ventilation supplies plenty of oxygen for best results and frequent turning of the eggs stimulates the interchange of oxygen for carbondioxide given off by the developing embryo. The CO_2 is then removed by the ventilation. It is not necessary to hold as high temperature in such a machine as it is in a deck type incubator. If one did, the chicks would hatch before the 21st day. Cabinet type incubators hatch well when operated at 99.5 degrees to 100 degrees F., although the correct temperature depends much on the percentage humidity in the machine.

It is not necessary to cool eggs in a farm or deck type incubator if it has a good ventilation system. Cooling retards development of the embryo by lowering the temperature of the eggs below the optimum for growth. While cooling encourages the interchange of carbon-dioxide within the egg for oxygen in the outside air, frequent turning of the eggs inside a well ventilated machine will secure just as satisfactory results in this respect without cooling. Where eggs are regularly cooled, it is necessary to operate the incubator at a temperature of from 102 degrees to 103 degrees F. in order to have the chicks hatch on time. A temperature of 101 degrees F. during the first week, 102 degrees during the second week and $102\frac{1}{2}$ to 103 degrees during the third week of incubation will hatch the chicks on time when no cooling is done. Most modern incubators are well ventilated and sufficient additional airing of the eggs is secured during the time the eggs are removed from the machine for turning. If the temperature should accidentally rise too high, the tray should be removed and set on top of the machine and the eggs allowed to cool for a short time. The incubator door should be kept closed while turning the eggs in order that the eggs when returned to the inside will return to hatching temperature quickly.

The eggs should be turned at least twice each day, commencing on the third day, although in cabinet machines they are turned from the time they are put into the incubator. Turning prevents the embryo from adhering to the shell membrane and also exercises the embryo. Three or four turnings per day will increase the percentage hatch from 2 to 5 per cent above that secured where only two turnings are given. Machines with mechanical turning devices allow eggs to be turned easily

and quickly. When eggs must be turned by hand the value of the time involved in giving more than two turnings per day may offset any improved hatch secured. Turning is discontinued on the eighteenth day. It should be remembered that eggs should be turned fairly gently, as rough handling is detrimental to the production of a good hatch.

It is wise to follow the manufacturer's instructions until such time as experience indicates suitable changes for the operator's particular conditions.

Hatching by the Natural Method

Setting the Hen: It is generally agreed that, in order to secure a good hatch, the hen must be placed where other hens are not likely to disturb her, for, as a rule, we seldom get good hatches when other hens lay in the nest with the setter. Some farmers do not set a hen until one becomes broody on a nest where no others lay. Such a practice often results in the production of late hatched chicks. The difficulty can be overcome by making a new nest for the broody hen. For this purpose one may use a box about twelve inches square and six inches deep. Place some earth or an overturned sod in the bottom, being careful to have the corners very full so that no eggs can roll out from under the hen and become chilled. Place about two inches of straw or chaff on top of the earth and shape it to the form of the nest, then place in it a few nest eggs or cull eggs for the hen to set on. The hen should be set in some pen where nothing will disturb her. She will usually set better if moved to the nest after dark. Feed and water must be within easy reach, and a dust bath should also be convenient. If on the following day the hen is setting quietly you will be safe in putting the eggs under her. We get ninety per cent of the hens to set by the use of this method. The hen should be dusted with Sodium Fluoride or some other good insect powder when set, and also a few days before the hatch comes off. This treatment will control body lice and, therefore, keep the hen more comfortable.

Selection of Eggs for Hatching

Select for size, shape and colour. In view of the weight standards for market eggs, it is wise to select eggs for hatching which are two ounces or better in weight. It is well to keep in mind that two-ounce pullet eggs are equal to a somewhat heavier egg from the same bird as a hen. Continuous selection, year after year, will give results. Do not select dirty eggs nor handle eggs with soiled hands. The egg shell is porous, hence there is a possibility of contamination.

Eggs deteriorate in hatching quality with age. When holding eggs for hatching, keep them in a cool place at about fifty to sixty degrees Fahrenheit. The temperature should be uniform. Be sure that the place is clean and not musty. Eggs for hatching should be kept not longer than ten days, and the sooner the eggs are set after being laid, the better the hatch is likely to be.

CHICK REARING

The greater percentage of chicks are range reared and with the average individual this is much the better system. There is, however, an increasing tendency to start many of them indoors for a few weeks, particularly from the early hatches. It is also a fact that each season more chicks are being raised indoors from hatching time to market age.

When chicks have no opportunity of getting out on range and eating materials that grow in the fields such as grass, insects, etc., and are kept out of direct sunlight, it becomes necessary to supply a ration which will provide for these deficiencies. It must contain not only a mixture of the cereal grains or their by-products, but a variety of animal proteins and minerals, plus the vitamins.

EXPERIMENTAL STUDIES OF THE VALUES OF VARIOUS CEREAL GRAINS IN CHICK RATIONS

Four cereal grains—corn, wheat, oats or oat groats (oats with the hull removed) and barley, together with their various milling by-products—are most commonly used in rations in Ontario. The amount of corn grown in Ontario is not sufficient to supply the needs of the poultry industry. Much of the corn used is imported and the substitution of some home-grown grains for this corn would be of economic importance. Before such a substitution can be made with any degree of safety it is necessary to know the effect of each of these grains in a ration. A series of experiments designed to study the comparative values of certain cereals in chick rations has been carried on for three years.

Fifty to sixty Barred Plymouth Rock chicks from similar matings were started on each diet immediately on removal from the incubator. These feeding trials were conducted indoors for twelve weeks in single-tiered, wire-floored, battery brooders. The chicks were individually weighed each week and at the end of the experiment were examined for the amount of feathering over the back, leg development, etc.

Although various protein supplements were used, both in combination and singly, at various levels, a consideration of one series using a combination of buttermilk powder and fish meal will suffice to bring out the more important findings. It should be pointed out that the results indicate that a mixture of protein supplements will, in general, give better results than will any single protein supplement, in so far as the growth and development of young chicks are concerned. However, the efficiency of any protein supplement depends upon the other ingredients in the rations. This will be discussed later.

The diets were made up as follows:

Cereal grain	100 lbs.
Buttermilk powder	10 "
Fish meal	7 "
Alfalfa meal	5 "
Bone meal	1 "
Oyster shell	2 "
Iodized salt	$\frac{1}{2}$ "
Cod liver oil	1 pint.

The cereal grain was either corn, wheat, oat groats or barley alone, or a mixture of equal parts of each of these four grains. Some typical results are shown in Table No. 20 for each of the two years, 1931 and 1932. Similar results were obtained in 1933 and 1934.

In Table No. 21 are shown some typical growth responses on the individual grains with single protein supplements. These supplements were 25 pounds of buttermilk powder, or twelve pounds of fish meal, or sixteen pounds of meat meal, all supplying approximately nine pounds of crude protein.

TABLE No. 20.—INFLUENCE OF CEREALS ON GROWTH AND DEVELOPMENT

1931

	Weights (grams) (12 weeks)		Percentage Feathering		Percentage Deformed		Percentage Beak		Percentage Mortality		Pounds of Feed per
	Average	Cockerels	Pullets	Cockerels	Pullets	Legs	Necrosis				
Mixed Cereals	944	957	927	24	76	2.6	2		20		3.8
Corn	953	999	901	23	70	23.5	0		17		4.5
Wheat	820	900	731	24	37	0	10		12		4.8
Oat Groats	775	835	728	23	52	0	31		17		3.4
Barley	735	734	737	32	75	0	25		40		4.8

1932

Mixed Cereals	906	955	829	22	74	5.5	11		30		4.0
Corn	957	1055	880	11	32	28.1	0		29		4.6
Wheat	968	1035	902	19	72	0	12		51		4.0
Oat Groats	844	812	890	20	70	3.4	69		40		4.6
Barley	891	936	841	36	78	2.3	45		19		3.6

TABLE No. 21.—INFLUENCE OF CEREALS ON DEVELOPMENT WITH VARIOUS PROTEIN SUPPLEMENTS

Protein Supplement	Cereal	Weights (grams) (12 weeks)			Percentage Feathering		Percentage Deformed Legs	Percentage Beak Necrosis	Percentage Mortality	Pounds of Feed per Pound Gain
		Average	Cockerels	Pullets	Cockerels	Pullets				
25 lbs. Butter-milk Powder	Corn ..	885	990	807	16	25	32	0	24	4.1
	Wheat Oat Groats	814	900	731	24	37	0	5	29	5.1
		845	879	787	45	78	0	20	6	3.7
	Barley	755	752	757	32	82	0	17	10	4.8
12 lbs. Fish Meal	Corn ..	760	784	732	6	21	10	2	40	5.0
	Wheat Oat Groats	752	753	750	34	72	6	14	46	4.8
		833	878	786	45	55	6	65	30	4.4
	Barley	761	783	746	43	74	3	31	46	4.7
16 lbs. Meat Meal	Corn ..	487	500	482	42	57	45	0	76	8.0
	Wheat Oat Groats	586	612	556	31	50	47	6	62	8.4
		705	776	644	32	75	3	53	33	5.1
	Barley	722	778	678	71	73	44	37	37	5.8

It is impossible, with our present information, to account for the differences in growth resulting from these various cereal grains, particularly when fed with a mixed protein supplement, but they do indicate the advisability of using a mixture of cereals in chick rations, rather than relying upon any single grain.

From Table No. 21 it will be seen that the various grains respond differently with various protein supplements, showing that the efficiency of the protein supplement depends, to a certain extent, upon the other ingredients in the ration. Such protein supplements as buttermilk powder, fish meal and meat meal differ in the quality of protein which they contain and the use of a mixture of such supplements in a chick ration is a safer practice. Thus the difference in the growth of the chicks fed corn with buttermilk powder, and those fed corn with meat meal, can be explained, partially at least, by differences in the quality of these two protein supplements. However, the differences in growth between the groups of chicks fed corn and buttermilk powder and those fed barley and buttermilk powder cannot be so explained.

No single protein supplement is completely satisfactory although if the necessity arises, milk in some form is probably the safest and most satisfactory. Likewise, it will be evident from the results shown that no single cereal grain is without liability and a mixture of cereal grains is a safer practice.

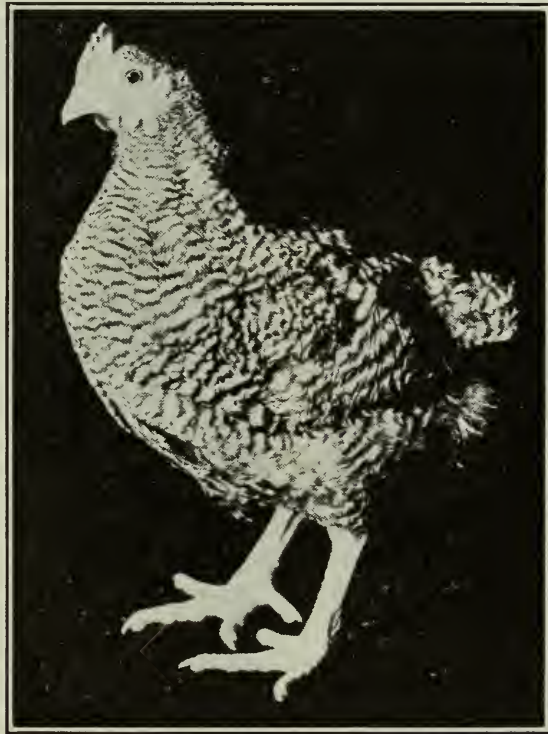


Fig. 9. A Barred Plymouth Rock cockerel showing normal bone growth, and feathering characteristic for barring and quality of feather.

The chicks raised on rations in which wheat was the sole cereal generally show a high mortality. The toxic factor responsible is not known since the various milling by-products such as bran, middlings and shorts, also resulted in high mortality if used excessively. Hence an excess amount of wheat should not be used in chick rations. Fortunately wheat is usually too expensive for such excessive usage.

The use of corn as the sole cereal results in a high percentage of deformed or crooked legs. This condition is distinct from rickets or "leg weakness" which results

from a lack of vitamin D as furnished by cod liver oil or sunshine. The condition resulting from a high corn intake is called "slipped tendons" or perosis, since the tendon at the back of the tibia-tarsal-metatarsal joint often slips from place. See Figs. 10 and 11.

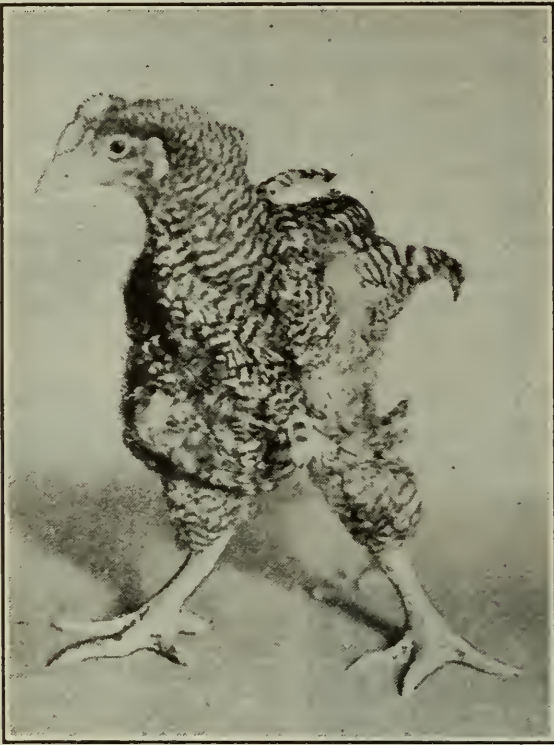


Fig. 10. Chick grown on a corn ration showing leg deformity occurring in such rations containing a high percentage of corn. Note that the tendons have not slipped from the tibia-tarsal-metatarsal joint, although the legs are bent. Also note the feather growth.



Fig. 11. An abnormal leg condition, commonly known as "slipped tendon" since the tendon slips from the tibia-tarsal-metatarsal joint (hock joint). This condition frequently occurs on a high corn intake.

In determining the percentage of deformed legs, any leg bone showing bending or bowing, or a slipped tendon, was included. The occurrence of this production of abnormal legs on a high corn intake has been repeatedly confirmed, using corn from various sources. A high intake of hominy will also cause this deformity. The development of the condition can be prevented to a considerable extent by the inclusion of oats or of oat hulls and germ, or wheat germ, in the diet. Examination of the bones of chicks fed on a corn diet shows a rather coarse, spongy bone, whereas the leg bones of chicks fed on oats or oat groats are fine, clean-cut, solid bones.

An excess of minerals in the diet will also result in similar leg deformities and will aggravate the perosis due to a high corn intake as shown in Table No. 20, where the protein supplement was meat meal, and to a less extent with fish meal. See Fig. 12.

Both meat meal and fish meal contain a considerable amount of minerals, and this mineral content added to that already in the diet will constitute an excess if large enough quantities of those protein supplements are fed. It is probably advisable to feed such mineral supplements as oyster shell and bone meal in separate hoppers and allow the birds to help themselves, rather than mixing such supplements in the mash.



Fig. 12. Crooked legs developed as a result of an over-dosage of minerals. Note the similarity of this condition to that resultant from a high corn intake (Fig. 10).

In general, birds raised on the corn diets are slow in feathering over the back, (see Fig. 10), and it seems evident that a high corn intake is detrimental to the growth or development of feathers. The result of other experiments designed to investigate the optimum levels of protein in chick rations suggest that either a deficiency or an excess of protein also influences feathering. Either condition seems to prevent the development of the barred feather pattern in Plymouth Rocks, the

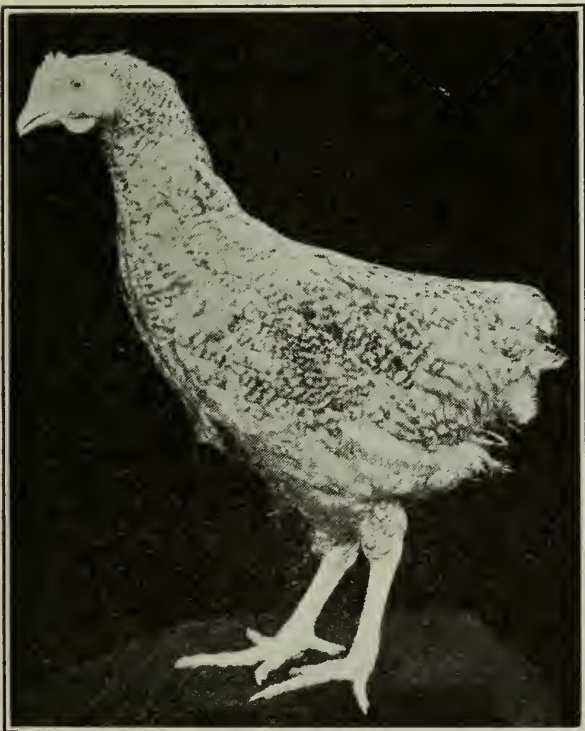


Fig. 13. Poor development of barred feather pattern resulting from improper protein level in diet.



Fig. 14. Note the poor development of the barred feather pattern as compared with Fig. 9, the normal chick grown on a balanced diet. This condition is the result of improper protein balance.

barring being smutty or indistinct. Hence the amount and quality of feathering is influenced, to some extent, by the ration fed. See Figs. 13 and 14.

Necrosis of the beak is believed to be due to the packing of soft, finely ground food in the beak, followed by subsequent inflammation and rotting. See Fig. 15.



Fig. 15. Chick growing necrosis of the beak, a result of using finely ground feeds that become pasty on moistening.

Finely ground grains such as oat groats, wheat and barley, which become sticky and pasty when moistened, result in this condition. Other experiments have shown that the condition does not develop if the grain is coarsely rolled or crushed, instead of finely ground.

These experiments show the advisability of using a mixture of cereal grains in chick rations. It is probable that at least two, and preferably three or more, grains should be used. No cereal when fed alone is satisfactory in every respect.

It should also be pointed out that these feeding trials were conducted in batteries indoors and that, in so far as growth is concerned, the same results might not be obtained if the chicks were raised outdoors on range. When chicks are on range they have a better opportunity to balance their ration since they eat bugs, grass and possibly obtain some nutritive material from the soil. However, it is doubtful if even range conditions would make good all the liabilities of single cereal grains. Yellow corn contains vitamin A and although other grains, such as wheat, oats and barley do contain the vitamin, the amount is small. If wheat, oats and barley are used as the cereal grain mixture in a ration, vitamin A, which is necessary for growth and resistance against infections, might be low and should be assured by another source, such as a good quality of green feed or cod liver oil.

BROODER PRACTICE

Preparing a Brooder for Chicks:

A—A colony house twelve feet square will accommodate three hundred chicks to five or six weeks of age or in other words, allow one-half square foot of floor space per chick to the age of five or six weeks, and for the following six weeks

double the amount of floor space, or reduce the flock to one hundred and fifty chicks.

B—Do not place the colony house close to trees, buildings or other obstructions to air current, otherwise one may have considerable trouble with lack of draught and a slow burning coal fire.

C—Place your brooder as near the centre of the pen as possible, and our experience has been that the stove burns better if the pipes go straight up through the roof.

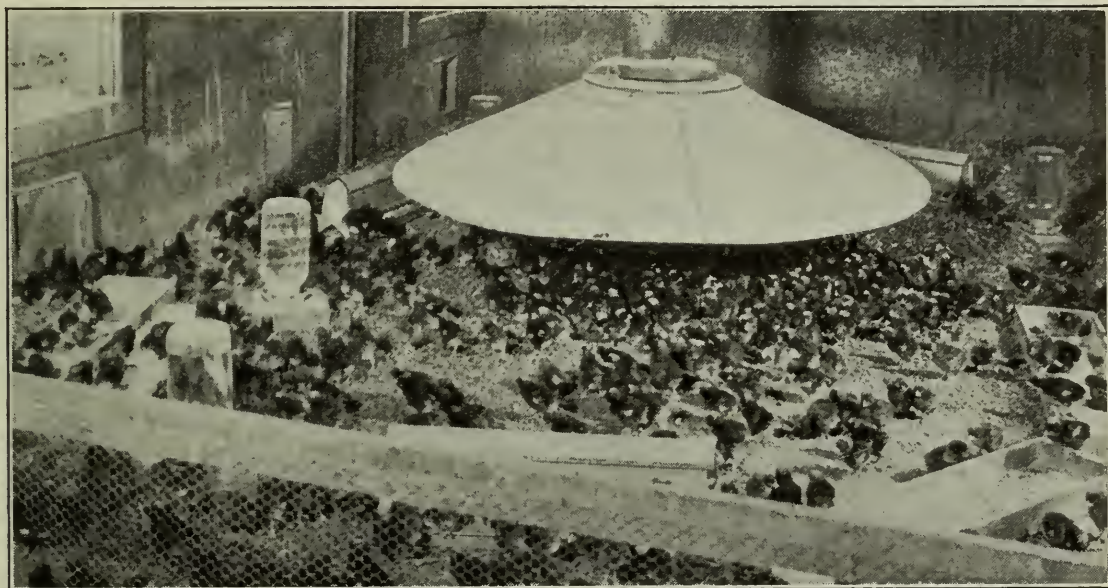


Fig. 16. Coal burning colony brooder stove, with baby chicks, hoppers and fountains.

D—The temperature of the brooder pen is important. In most cases a temperature of one hundred degrees with the thermometer placed two inches above the floor, underneath the hover, will be satisfactory. However, the best temperature guide is the behaviour of the chicks themselves. The hover temperature should be high enough that the chicks will settle down in the evening around the outer edge of the hover. They should never crowd close to the heater, due to low temperature. Battery brooding will not require as much heat as floor brooding.

E—Chilling and overheating are very apt to cause bowel trouble. The floor of the pen should be free from draughts. Early in the season it may be necessary to line the house with paper to prevent floor draughts.

F—Learn how to operate the brooder stove before you put the chicks around it, and remember that high windy days and nights mean more attention to the stove or the fire may burn out.

G—Run a circle of wire netting of one inch mesh around the hover at least two feet from its edge. This keeps the chicks near the source of heat and prevents bunching or crowding. Watch the corners of the pen. It is generally good business to put some wire netting across the corners so that the chicks cannot bunch or pile in them.

H—Use one drinking vessel for each fifty chicks. A chick hopper two feet long and open to feed from both sides is ample for fifty chicks for the first three weeks; after this age, double the number of hoppers.

I—If the sun shines in the pen near the brooder, white-wash or cover the windows for at least the first week. Chicks like to huddle in the sunshine and some broods learn to bunch or crowd in this way.

J—Keep the chicks comfortable and the air pure. The odour of the pen will suggest the amount of ventilation.

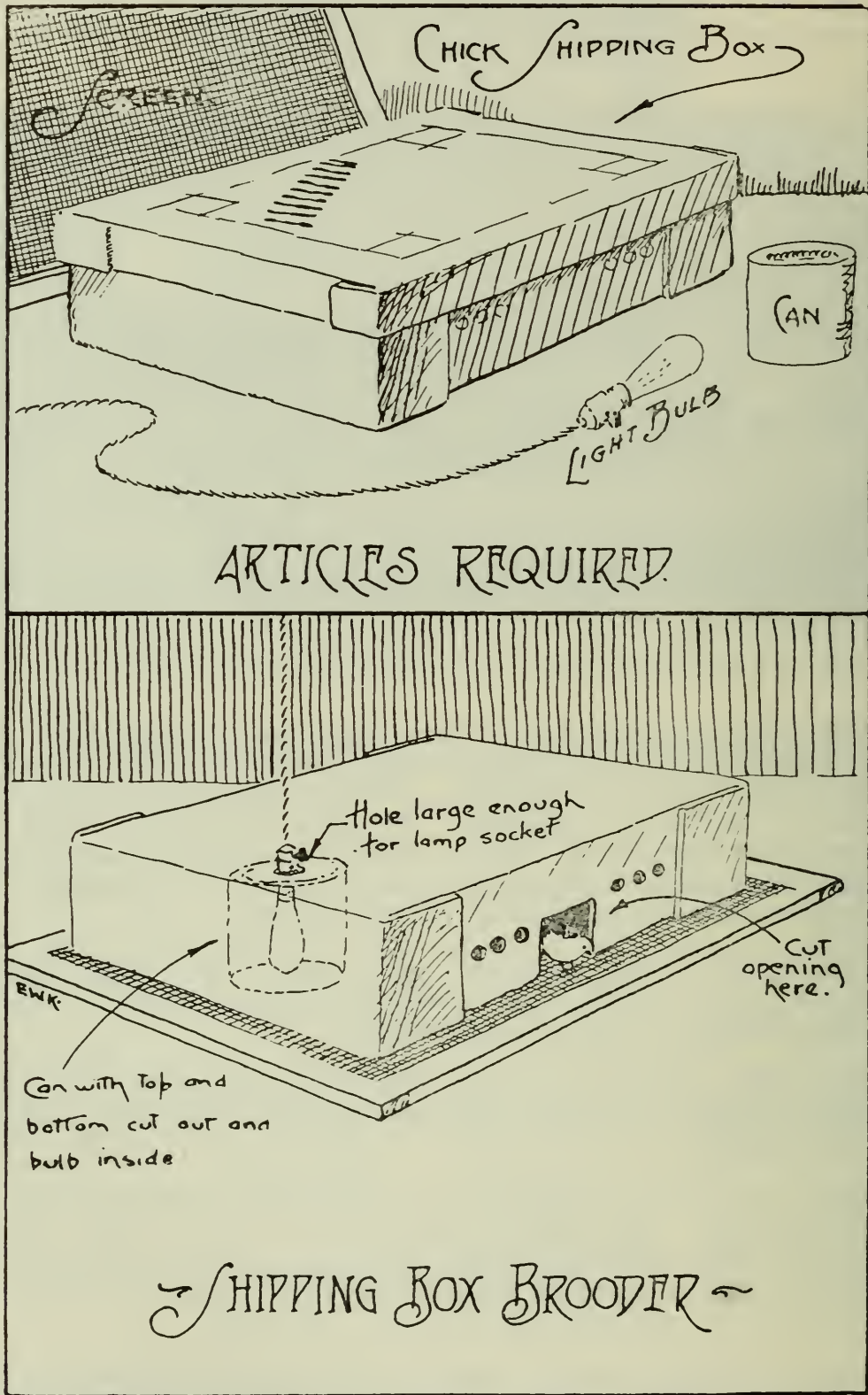


Fig. 17. Shipping box brooder, heated with an electric light bulb, 40 watts.

K—It is a good plan after the first week in the brooder to have a small box of grit and fine oyster shell for the chicks to eat.

L—Put in small roosts as soon as the chicks desire to perch. They will sit on the perches considerably during the day, long before they roost at night; but all the time they are getting the roosting habit and once on the perch at night they require much less attention.

M—Care must be taken to keep the pen clean and dry. Do not have moist litter near the drinking vessels or anywhere in the pen. Clean the pen at least once each week, and oftener if necessary.

N—Keep the chicks comfortable.

CHICK RATIONS AND FEEDING PRACTICE

The following chick starter rations have been found quite satisfactory.

The baby chick Cafeteria ration is developed from the results of free choice feeding and has been found to give good results for either battery or open pen feeding of chicks. Chick vices are comparatively rare on this mixture.

Cafeteria or Free Choice Baby Chick Ration

310 lbs.	rolled wheat	
60 "	bran	
100 "	wheat germ or	{ 50 lbs. wheat germ
		{ 50 " wheat middlings
320 "	white hominy	
340 "	ground yellow corn	
100 "	rolled barley	
300 "	rolled oat groats	
100 "	ground oats	
60 "	ground peas	
40 "	soyabean oil meal	
140 "	powdered milk or	{ 100 lbs. powdered milk
		{ 40 " cereal grass
80 "	meat meal	
20 "	fish meal	
10 "	cod liver meal	
20 "	cod liver oil (or other fish oil) containing about 1,000 international units of vitamin A and 100 international units of vitamin D per gram.	

Bone meal, oyster shell and grit to be supplied in separate, accessible hoppers.

For the poultryman wishing to mix his own chick ration the one given below is simpler and the ingredients more easily obtained. It also offers the opportunity to make more use of home-grown materials.

Chick Starter Ration (Home Mixed)

Equal parts by weight of:

Ground yellow corn (grade equal to No. 2 natural)

Ground wheat

Ground barley

Ground hulled oats, or ordinary oats with the hulls sifted out.

Rolling the wheat and hulled oats might improve the physical condition and prevent stickiness of the mixture.

To each 100 pounds of the mixed ground cereals add:

- 5 lbs. buttermilk powder
- 5 " fish meal
- 5 " meat meal
- 5 " alfalfa leaf meal
- $\frac{1}{2}$ " iodized salt

1 pint of cod liver oil (or other fish oil) containing about 1,000 international units of vitamin A and 100 international units of vitamin D per gram.

Bone meal, oyster shell and grit to be supplied in separate, accessible hoppers.

Where it can be secured, the addition of 5 pounds of wheat germ meal to each hundred pounds of feed is advisable.

The cod liver oil is mixed with some ground corn and then sifted into the entire mixture. This facilitates mixing of the oil. The entire mash must then be well mixed.

Where one has plenty of liquid milk as drinking material for the chicks practically all meat meal, fish meal and buttermilk powder may be left out of the ration.

The chicks may be fed as soon as they are taken from the incubator. Chicks will live very well for three days without food. The matter of the age of the chicks at the time of the first feed is, to a large degree, a question of convenience so long as the chicks are not much more than three days old.

Either of the above mixtures may be fed from the time the chicks are put in the brooder until they reach broiler age.

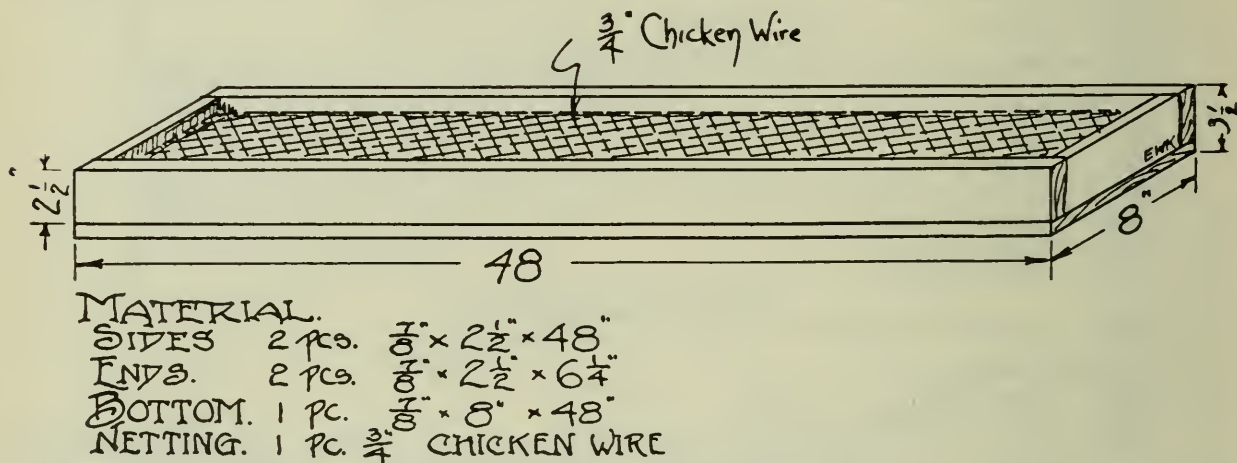


Fig. 18. Plan and specifications of a home-made chick feeder for feeding dry mash to young chicks in the brooder.

The starter mash is fed in hoppers. One may keep the feed constantly before the chicks or adopt the stop-and-go method of feeding where the feed hoppers are removed for two hours every two or three hours during the day, or two to three hours in, and two hours out.

After the chicks are two weeks old some feeders follow the practice of feeding some medium finely cracked grains such as wheat, corn and oat groats in equal parts. The practice has some points in its favour and no harm will result from the use of this material. The more hard grain eaten the less mash consumed, hence the lower is the animal protein intake. One may slow up the rate of growth unless additional protein such as milk to drink or some other form of animal protein is fed. Where chicks are in-doors it may be desirable to feed some alfalfa or clover leaves or some sprouted grains.

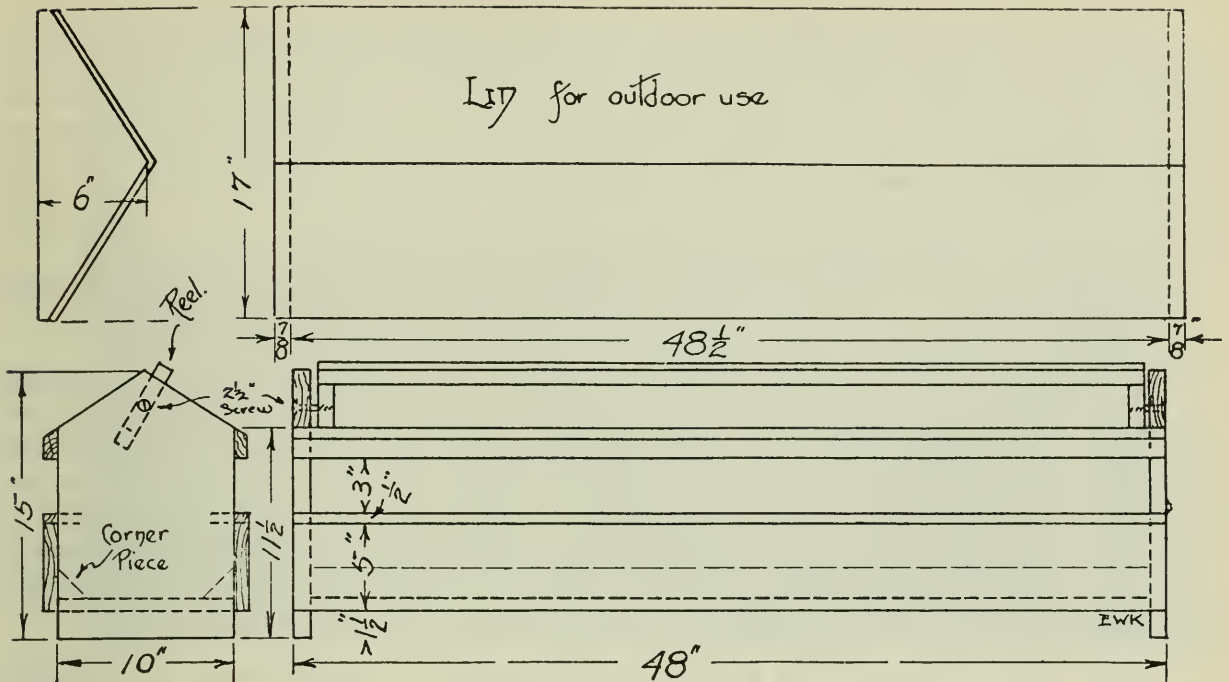


Fig. 19. Showing plans for the construction of a reel type of dry mash hopper. This is adapted for the feeding of dry mash to growing chicks on range, in which case the lid is used. It may also be used for feeding dry mash to laying hens by removing the lid and inserting the reel.

BILL OF MATERIAL

Bottoms.....	1 pc.	$\frac{7}{8}$ " x $9\frac{3}{4}$ " x $3' 10\frac{1}{4}$ "
Ends.....	2 "	$\frac{7}{8}$ " x $9\frac{3}{4}$ " x 19"
Sides.....	2 "	$\frac{7}{8}$ " x $4\frac{3}{4}$ " x 48"
"	2 "	$\frac{3}{8}$ " x $1\frac{3}{4}$ " x 48"
Divisions.....	2 "	$\frac{7}{8}$ " x $3\frac{7}{8}$ " x $9\frac{3}{4}$ "
Tumbler.....	2 "	$\frac{7}{8}$ " x $\frac{7}{8}$ " x $3\frac{1}{10}$ "
"	2 "	$\frac{7}{8}$ " x $\frac{7}{8}$ " x $2\frac{1}{4}$ "
Top.....	2 "	$\frac{7}{8}$ " x 6" x 17" (cut to detail)
"	2 "	$\frac{3}{8}$ " x $9\frac{3}{4}$ " x $4' 2\frac{1}{4}$ "
"	2 "	$\frac{7}{8}$ " x $1\frac{3}{4}$ " x 48" bevelled one side.

When chicks are five to six weeks of age, and especially where they are being grown to maturity, it is advisable to gradually change from the starter ration to growing mash. This latter is made up of coarser materials. The Cafeteria growing ration below will fit in very nicely after either of the starter rations given.

CAFETERIA OR FREE CHOICE GROWING MASH

350 lbs.	yellow corn meal
90 "	yellow hominy feed
180 "	white hominy feed
480 "	rolled wheat
50 "	wheat middlings
50 "	wheat germ
40 "	wheat bran
125 "	rolled barley
400 "	crushed oats
40 "	oat middlings
20 "	ground peas
20 "	soyabean oil meal
70 "	meat meal
30 "	powdered milk
25 "	fish meal
10 "	iodized salt
20 "	cod liver or other fish oil containing about 1,000 international units of vitamin A and 100 international units of vitamin D per gram.
	Bone meal, oyster shell and grit to be supplied in separate, accessible hoppers.

Cod liver oil, or other fish oil, has been included in this formula but if the birds are out on good range, with plenty of green feed, during the Summer months, the oil may be omitted from the ration and the rolled wheat increased to 500 pounds. If the growing mash is fed to birds confined indoors, or to birds which are outdoors early in the season, the oil should be added to the ration. If there is little or no green feed during the hot Summer months it would appear to be safer to mix cod liver oil or other fish oil in the growing ration.

An abundant, continuous supply of clean, fresh drinking water must always be available.

A practice that is now followed in growing stock on range is to feed crushed oats and barley in hoppers, in addition to the growing mash, allowing the birds to make their own selection of feed. The crushed grain feeding is started a week or ten days after the feeding of the growing ration begins. Later, when the chicks are about nine or ten weeks old, equal parts of cracked corn and wheat may be fed in hoppers, in addition to the other materials. This will tend to slow sexual development and delay egg production, but will produce more growthy, larger birds at possibly lower cost.

Many good chickens have been grown on range on crushed oats, whole wheat and a good pasture, together with sour skim milk or buttermilk to drink. One should be careful where using crushed oats or barley to remove daily the hulls from the hoppers. The more fibre in the feed the greater is the need for an abundant supply of hard, insoluble grit.

Bone meal and oyster shell should be fed in separate hoppers, available at all times.

PASTURES FOR POULTRY

The value of special pasture crops for poultry, especially growing stock, is now becoming generally recognized. Available information indicates that better chickens are grown, and with less mortality, where the birds are provided with a constant supply of short, tender green feed throughout the Spring and Summer months. There is further evidence that where birds are grown under such conditions there is likely to be less trouble and mortality among the same birds as adults. However, it must be recognized that if any pasture programme is going to be of any particular value it must receive definite, regular attention throughout the season.

A start should be made on a pasture programme in the early Summer or Fall so that there is a green crop available in the early Spring. A patch of Fall rye is perhaps best for this purpose. If possible, the colony houses should be cleaned in the Fall, moved to the patch of rye and set up on blocks so the floors will be dry. In the Spring the houses are let down off the blocks, ready for the chicks as soon as weather conditions will permit their use. This will provide green pasture for several weeks before a Spring crop would be ready.

Just as soon as it is possible to start seeding, Spring grains are sown, preferably oats. In this case the rate of seeding should be double that used for a grain crop. Four, or even five, bushels per acre are advisable. It has been found advisable to apply commercial fertilizer at the rate of three hundred pounds per acre when making the first Spring seeding. The fertilizer used is, preferably, one high in phosphates, such as a 4-8-10. This dressing of fertilizer speeds up growth and increases the volume of vegetation, in addition to improving the nutritional value of the pasture.

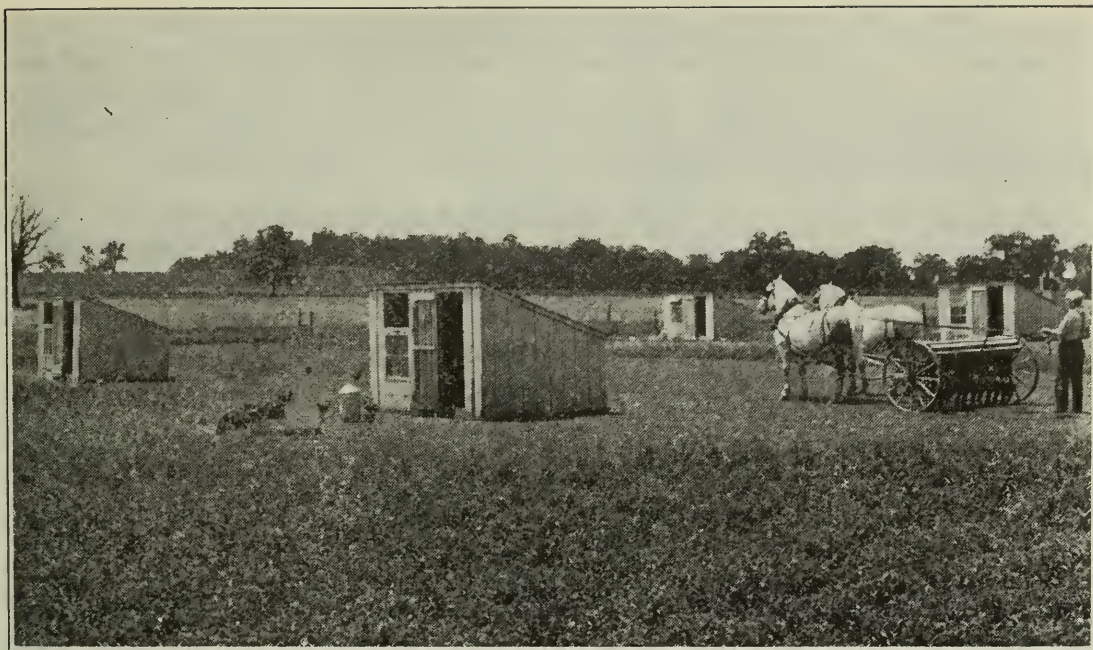


Fig. 20. Range scene.

Heavy pasture growth in the foreground; forage is eaten off in front of the colony houses; land in the rear of the nearest colony house has been pastured off, ploughed, and is being resown for later pasture.

Later seedings of the grain may be made at ten to twelve day intervals until about the middle of June. During the first half of that month, plantings of corn should be made in drills one foot apart, or every other spout of the grain drill. Rape may be broadcast from the seed box at the same time the corn is being drilled in, or it may be sown as a separate crop. Kale or swiss chard are also useful for mid-summer pasture crops but are best sown in drills and cultivated in the early stages of growth to control weeds. These latter crops will probably grow better than the cereal grasses in the hot weather of July and August.

Grasses of all species, including the cereals, have their highest nutritive value when short, or before stem growth or jointing commences. Rape, kale, swiss chard



Fig. 21. Strip cultivation and pasture crops with colony houses and range shelters well distributed to provide adequate pasture for all stock.

and corn are possibly more valuable at later stages in their growth. One should aim therefore to furnish a sequence of grass crops that will provide that stage of growth which is most valuable. With most cereal grasses stem node formation will occur at from thirty to forty days from the date of seeding, depending upon temperatures and moisture or generally favourable growing conditions.

As soon as the crop is pastured off the land used for Fall rye or early Spring seeding the ground may be cultivated and reseeded or planted to later crops. Strip cropping is most satisfactory for this type of programme. Under average conditions one would need to plan for at least one acre of the mixed crops suggested above for each four hundred birds.

Fencing of these pasture crops is not essential. While chickens may dig up some of the seed before it reaches an ideal stage of growth for pasture, it must be recognized that a bird is only going to eat a given amount of feed and if it eats the oats before they have started to grow it will eat much less of something else. The activity provided in the digging may be of value.

Chickens can be grown in confinement but most of those so grown lack the normal bloom and condition of those grown out of doors. One may be forced to grow them off the ground owing to lack of suitable range but it is well to remember that a good grass range helps the general physical condition and growth of the chickens and reduces the cost of growing them.

When chickens are on range, supply sufficient hoppers and drinking fountains. It is important that these be moved four or five feet twice a week on to fresh ground. Do not over-crowd the birds in the houses or on the range at any time. The houses should be moved frequently enough to prevent the entire killing of the vegetation near them.

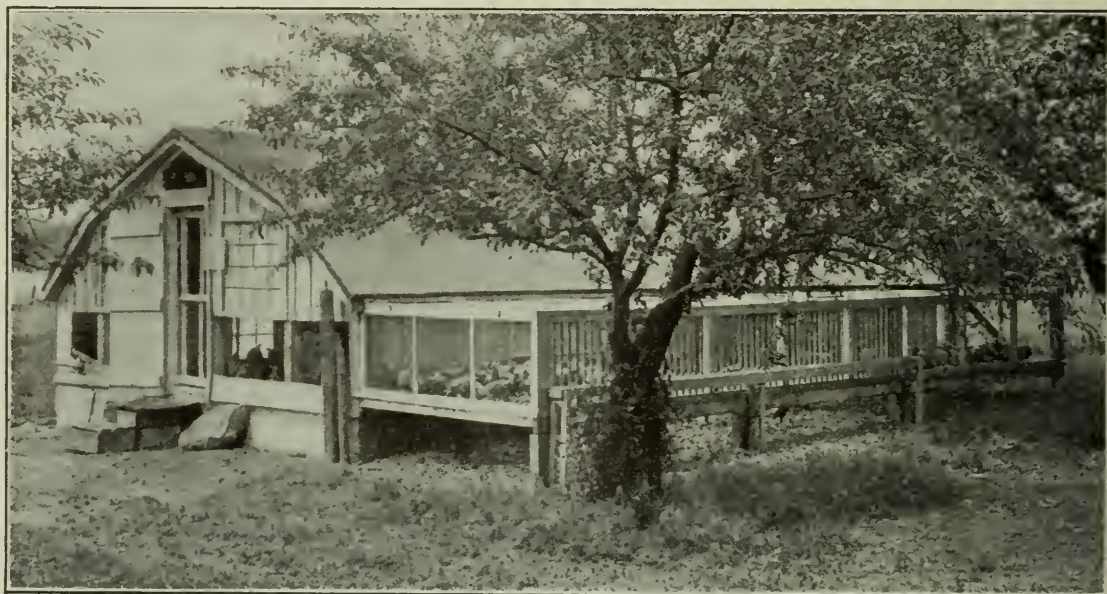


Fig. 22. Wire-floored rearing pen, of value in the control of Parasites and Coccidiosis, also for confinement rearing.

CHARACTERISTICS AND VARIATIONS IN BREEDS OF CHICKENS

The present high standard of quality of poultry has not come about by accident. It has taken many years of careful breeding to develop so many useful and beautiful breeds and varieties of chickens as are now available. Among this large variety of types and colours are to be found birds suitable for any purpose for which fowl may be desired. We have, therefore, birds in a variety of colours that are satisfactory for the production, in quantity, of either white or brown shelled eggs. Some make excellent market fowl, while still others combine a satisfactory egg production with the required fleshing to dress out a good carcass. There is also ample scope for the application of the skill of the exhibition breeder because all the above types, along with other specialized exhibition types, are beautiful as well as useful and, therefore, make splendid exhibition material.

The Single Comb White Leghorn is easily the most popular of the producers of white shelled eggs. This variety of Leghorn lays good sized eggs, stands confinement well, and can be successfully handled in large flocks. It has become popular as an egg producer for both large and small poultry farms. Among farmers and others who find the production of meat, as well as eggs, profitable, the Plymouth Rock is popular; especially may this be said of the Barred and White varieties of the breed. In this class should be mentioned also the White Wyandotte, the Rhode Island Red, and perhaps the Canadian breed of Chantecler. The Orpington and Sussex breeds also supply varieties suitable for this purpose.

Where the production of table fowl is stressed the Cornish Game, and more especially the first cross of the Cornish with Orpingtons, Jersey Black Giants, Plymouth Rocks or Brahmas, are satisfactory. Some strains of Plymouth Rocks, Wyandottes and Rhode Island Reds produce birds that dress out well. Other varieties of the above breeds are also useful commercially but are more popular for exhibition purposes.

Not all birds nor all strains of any one variety are equally good for egg production, meat production, or as dual purpose fowl; nor is one breed or variety necessarily superior to any other. It is possible, within certain limits, to select out of almost any variety birds excellent in meat or egg production, or birds of an intermediate type. Breeding from only such selected birds will soon result in a strain adapted to the purpose for which the selection is made. Where one has a preference for any particular type or colour of bird almost any suitable breed and variety may be chosen and then developed by selection for any purpose required of it. Trap-nesting, pedigreeing and progeny testing of the stock will facilitate the attainment of the desired goal.

In the production of these numerous breeds and varieties of fowl much credit is due the American Poultry Association, organized by representative poultry breeders of the United States and Canada in 1873. The "American Standard of Perfection," issued by this Society, has aided greatly in bringing about uniformity in breeding results. It has served as an incentive to greater effort on the part of many breeders. In it is described and illustrated the ideal in colour, shape and other points of each recognized breed and variety of chickens, as well as of geese, ducks and turkeys. The Standard is revised at intervals to keep up with the changing ideals of the leading breeders of the various breeds and varieties. In this way stress is placed on the breed characters which changing conditions in the trade, as well as in the show room, indicate should be emphasized.

Practically all present day breeds and varieties of chickens are the outcome of crosses made between birds of various types, colours and comb conditions. These

crosses were followed up with rigid selection towards an ideal until such ideal was, to a degree, attained. While careful selection has brought about considerable purity among the breeds and varieties, there are still numerous indications of impurity. These are known as standard disqualifications and since the majority, if not all of them are hereditary every breeder is well advised to discard all birds carrying such disqualifications. It is just as important for the production breeder to cull severely in this regard as it is for the exhibition breeder to do so. The purity and quality, as well as the egg production, are dependent on the attention given these points by breeders of production birds. This is true of poultrymen supplying hatcheries with eggs as well as those operating breeder hatcheries.

POULTRY BREEDING

In the breeding of poultry there are two main points to be considered; first, the selection of birds that have the characters desired; and secondly, a further selection from these of birds that can produce offspring as good as or better than themselves.

Many are of the opinion that "like begets like." In general this is true, but it is true for general and not necessarily for particular qualities. It is true that a White Leghorn male mated to White Leghorn females will breed chickens that are White Leghorns, or that have white plumage, yellow legs and white ear lobes, but of these offspring there will be no two chicks exactly alike. We find large and small Leghorns; most of them never go broody but some do; some lay large eggs, others small eggs. We also find a great variation in the number of eggs produced by different hens.

Selection is made on the basis that like will produce like, but experience has taught many breeders that to secure uniform superiority they must carry on the selection through generations of poultry. If we select birds that have laid better than two hundred eggs in twelve consecutive months and mate these to a male of similar strain, we do not expect to get daughters that will all lay two hundred or more eggs a year, but we do expect, on the average, a better production than if no selection had been made.

SELECTION

The first step in the breeding of poultry is the selection of the birds to make up the breeding pen. What birds are used in this pen depends upon the object of the breeder. Selection is made along the lines of the ideal in mind. The higher the ideal the fewer will be the individuals that will be considered suitable for the breeding pen.

No matter what may be the breeder's ideal, all agree that vigour is the one essential point that must be present; that is a bird must be healthy and active. Vigour means the bird's ability to thrive and live under ordinary conditions. The lower the vigour, the more easily the birds will sicken and die. Perhaps the male, which is the boss the entire flock, is the most vigorous or at least it would be safe to say he has considerable vigour.

It is important that the breeder should bear in mind that the various characters of the chicken may be inherited separately. Because Plymouth Rocks, for example, have single combs, red ear lobes and yellow legs does not mean that all such birds

having yellow legs must have single combs and red ear lobes. By means of this inheritance of single characters, the breeder is enabled to correct single defects in the birds bred, and at the same time maintain and improve the good points.

It is, therefore, plain that the first essential is the selection of birds that have the characters wanted, and the next step is to test their power to transmit these characters. Our experience has been that certain birds, male or female, are excellent for breeding one character but fail in others; for instance, hen H 19 has never bred a bird without positive bright yellow legs. She appears to be able to transmit this character to all her offspring. Again, we find birds that transmit several desirable characters very well, but may likewise transmit one very undesirable character. As an example of this, male 2227 produced daughters that were very satisfactory in all respects with the exception of size and colour of eggs. In the end the breeder selects, then tests the selected birds for their ability to produce offspring as good or better than themselves.

The most interesting and at the same time the most progressive method of breeding is to know the parentage of each chick, and thus be able to tell which birds are reliable breeders. There is a great difference among birds in their ability to transmit certain characters, as one may find in any ordinary selecting process in a pure-bred flock. Some birds are good breeders; others appear to be of very little account.

The more selections that are made and the more tests of progeny the less is the percentage of undesirables found. One may expect some considerable variations within a group, but one may likewise expect a smaller number of inferior stock with each generation.

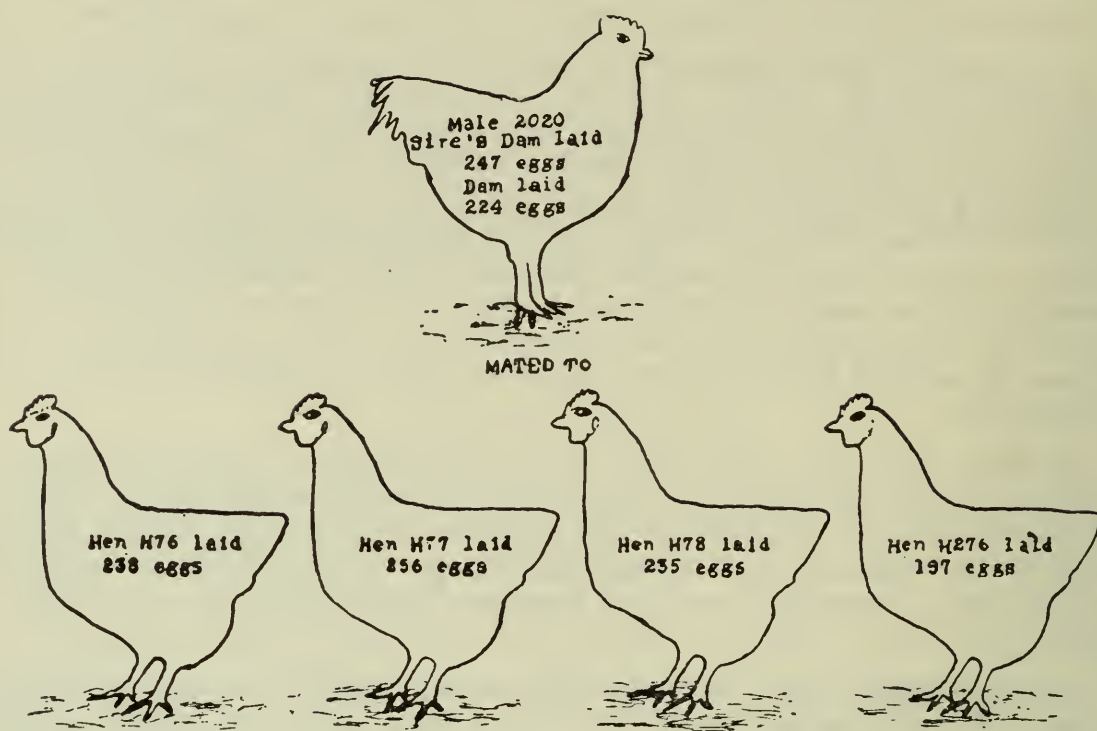
PROGENY TESTING

The following tables give the results of a test of four Barred Rock males and the hens bred to them, each of which has had four or more daughters that completed a year's trap-nest record. Where a hen has fewer than four pullets it is more difficult to estimate her value as a breeder. The results from hens with less than four daughters do not alter the indicated value of the male as a breeder beyond the figures given. They are of some interest in establishing the value but where space is limited it has been considered wise to omit such hens from the figures given.

It must be remembered that in this progeny test only the number of eggs laid are considered. This is some indication as to the hens' ability to produce pullets, as is indicated by H 237, H 19 and H 262.

A practical breeder would have to bear in mind such things as breed-type and colour, size and colour of eggs, hatchability, growth of the chicks and the number of eggs set to secure a mature bird.

Results of breeding Male 2020 to Hens H 76, H 77, H 78 and H 276.



Daughters

Eggs laid

L 379 171
L 440 253
L 2631 133
L 3433 162
L 3220 151

Daughters

Eggs laid

L 45 189
L 311 162
L 386 221
L 2637 171

Daughters

Eggs laid

L 106 157
L 194 245
L 479 165
L 2518 123
L 2607 115

Daughters

Eggs laid

L 319 177
L 416 166
L 487 184
L 2551 155
L 2641 172
L 2649 141
L 3429 139

Notes on Male 2020

Male 2020 is the son of a 224 egg hen. The dam of his sire laid 247 eggs.

He was successfully bred to four hens which produce four or more daughters with trap-nest records for a year.

The mating produced three hens that laid two hundred or more eggs in their first year.

H 76 produced the highest laying daughter and this daughter's record exceeded her mother's.

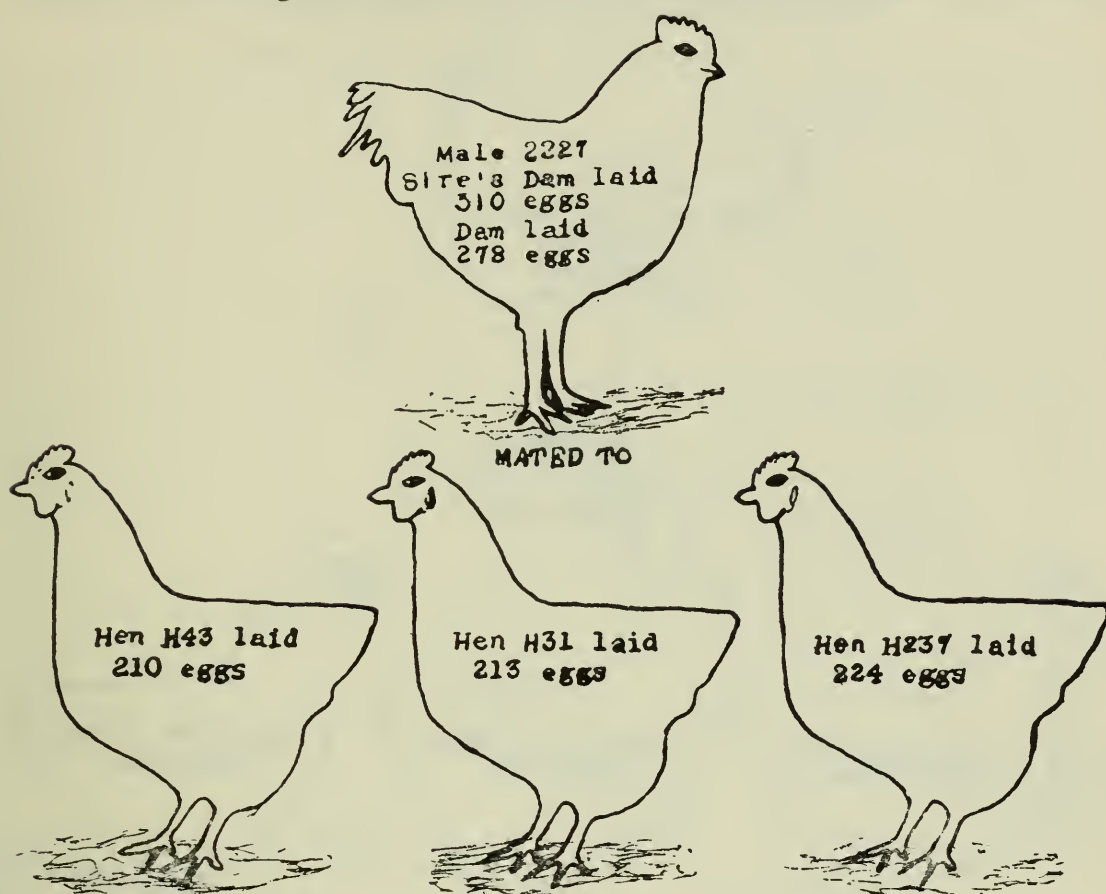
H 77 produced one daughter that laid two hundred eggs but was not as good a layer as was her mother.

H 78 produced one daughter with a record higher than the mother's.

H 276 produced no daughters equal to herself.

This mating would be considered very ordinary from the results obtained. From such a mating one would not expect future generations to be any better than the parents.

Results of Breeding Male 2227 to Hens H 31, H 43 and H 237.



Daughters

	Eggs laid
L 208	260
L 375	228
L 491	194
L 2526	130
L 2557	179
L 2572	191
L 2628	123
L 3436	193

Daughters

	Eggs laid
L 303	219
L 377	271
L 2529	242
L 2572	254

Daughters

	Eggs laid
L 70	202
L 221	204
L 318	227
L 352	244
L 400	227
L 437	224
L 474	249
L 492	223
L 2516	213
L 2582	190
L 2630	243
L 3905	235

Notes on Male 2227

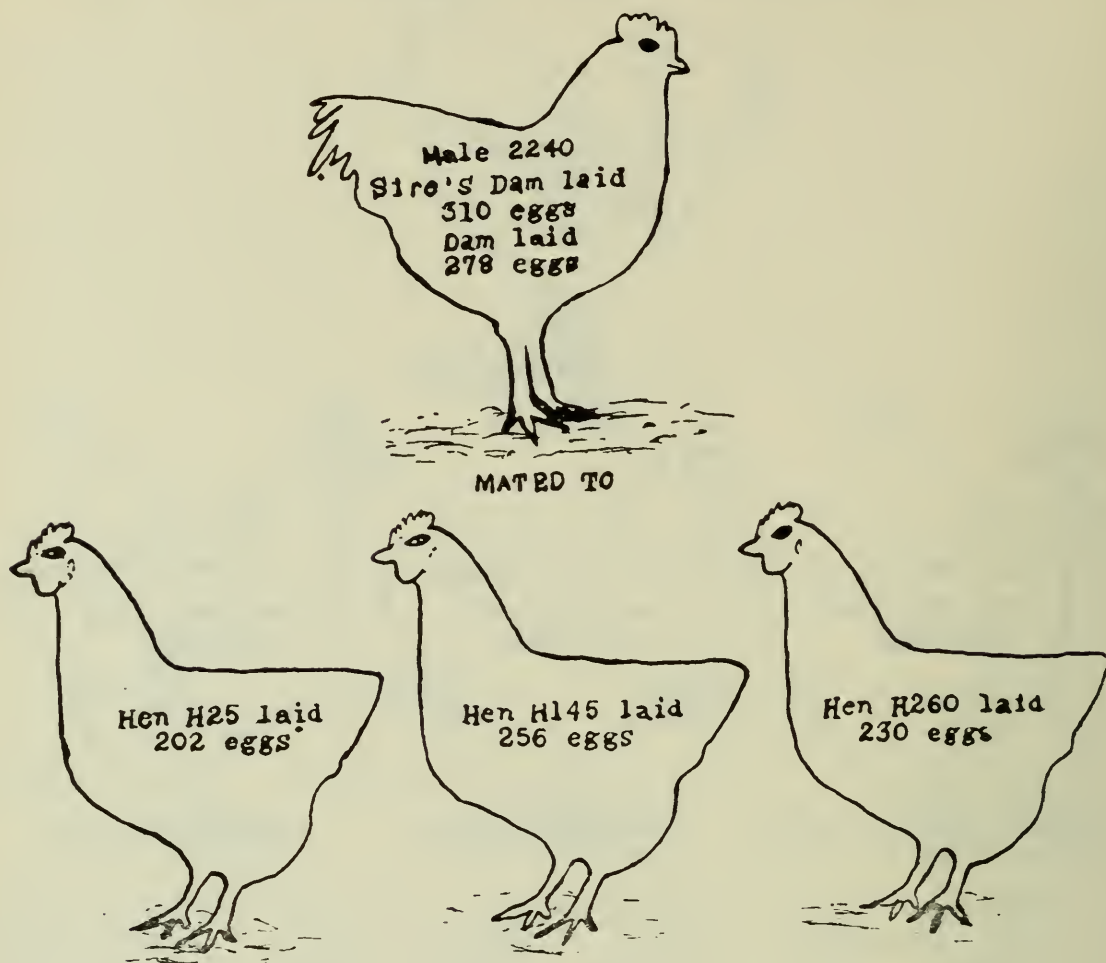
The general results of this mating were exceptionally good. Our experience has been that but few matings produce as many high laying birds as did this one.

Hen H 31 produced daughters all of which were better than herself. She also produced the highest laying individual.

Hen H 237 had a large number of daughters, indicating exceptional breeding ability for numbers. It is rare to get a hen with so many daughters that are all good layers. This is a very excellent hen and should be good foundation for a high laying family.

Hen H 43 did not breed as many high laying daughters and there is a wide variation among them. It is questionable if this hen had been bred to an average male whether her offspring would be very good. Sons of Hens H 237 and H 31 should be good males from which to breed.

Results of Breeding Male 2240 to Hens H 25, H 145 and H 260.
(Male 2240 is a full brother of Male 2227)



Daughters

	Eggs laid
L 15	 169
L 404	 211
L 451	 183
L 483	 214

Daughters

	Eggs laid
L 407	 224
L 439	 145
L 2612	 147
L 3208	 187
L 3210	 134
L 3215	 147
L 3237	 183

Daughters

	Eggs laid
L 369	 263
L 392	 202
L 2573	 222
L 2599	 105
L 2648	 180

Notes on Male 2240

The daughters of Male 2240 were, on the average, distinctly lower in egg production than those of his brother, 2227.

Hens H 260 and H 25 indicated that they would breed good stock. One would particularly desire to see the offspring from these hens mated to such a male as 2227.

Hen H 145 had no daughters equal to herself and most of the daughters were low producers. This hen would be discarded as a breeder.

Hen H 260 had one very poor daughter. Without further trials it is questionable what bearing this would have on her future breeding.

Hen H 25 had two daughters better than herself.

The good pullets from H 260 and H 25 would be worth using in breeding trials. The cockerels might be good breeders but one would prefer them from a better male.

Notes on Male 1518

Male 1518 was successfully bred to more hens that produced four or more daughters than any other males. He is a rather interesting male in that he has produced many variations, not only in the range of egg production from his daughters but in the way the daughters from the different hens performed.

The most successful mating was H 12. The daughters of this hen were uniformly good.

H 46 produced a wide range of daughters and the average results were not very good.

H 19 produced some high laying daughters and the average of all was very good.

H 99 performed much after the manner of H 46 but the average was better.

H 204 was in the same class as H 46 and H 99.

Hens H 205 and H 262 are full sisters and therefore the results from these two hens become very interesting. It will be noted that it is not always the highest laying hen that is best bred, nor yet the lowest. (Compare H 12 and H 262.)

The hens H 205 and H 262 are an excellent example of the value of testing the progeny for the characters under consideration.

H 46, H 99 and H 204 appear to be rather inferior breeders.

TABLE 22.—GENERAL RESULTS FROM ALL THE PENS

Mother	Egg Production of Mother	Number of Daughters	Average Egg Production of Daughters	Eggs Total
H 12	258	7	219.7	1538
H 25	202	4	194.25	777
H 31	213	4	246.5	986
H 43	210	8	187.25	1498
H 46	264	7	162.4	1140
H 76	238	5	174.	870
H 77	256	4	185.75	743
H 78	235	5	161.	805
H 99	265	5	181.	905
H 19	262	14	195.	2730
H 237	224	12	223.4	2681
H 145	256	7	166.7	1167
H 204	197	4	171.75	687
H 260	230	5	196.6	983
H 276	197	7	162.	1134
H 205	210	5	159.6	798
H 262	171	9	187.2	1685
Total Production 3888		112	3174.1	21,127
Average Production 228.7			186.71	188.63

It is not to be expected in the general results from a selected number of high laying hens that all the daughters will be high layers, or that the mother only controls the producing ability of the daughters.

Study the following tables as to the variations in breeding ability:

TABLE 23.—THE INFLUENCE OF THE MALE

	Mother's Egg Production	Number of Daughters	Average Egg Production of Daughters	Total Eggs
Male 1518 bred to H 12	258	7	219.7	1538
H 46	264	7	162.4	1140
H 99	265	5	181.	905
H 19	262	14	195.	2730
H 204	197	4	171.7	687
H 205	210	5	159.6	798
H 262	171	9	187.2	1685
Total	1627	51	1276.6	9483
Average	232.4		182.3	185.9
Male 2020 bred to H 76	238	5	174.	870
H 77	256	4	185.75	743
H 78	235	5	161.	805
H 276	197	7	162.	1134
Total	926	21	682.75	3552
Average	231.5		170.6	169.1
Male 2227 bred to H 31	213	4	246.5	986
H 43	210	8	187.25	1498
H 237	224	12	223.4	2681
Total	647	24	657.15	5165
Average	215.6		219.	215.2
Male 2240 bred to H 25	202	4	194.25	777
H 145	256	7	166.7	1167
H 260	230	5	196.6	983
Total	688	16	557.5	2927
Average	229.3		185.8	182.9

Summary

Of the four males under test, Male 2227 was the best breeder of high laying hens, and Male 2020 was the poorest.

Male 1518 bred some good daughters and by careful selection a very good line could be established, especially from the cockerels of H 12.

If one desired high laying hens and considered this character only, by taking Male 2227 and Hens H 12, H 31, H 237, H 19, H 262, H 25, H 260 and H 77, he would be reasonably sure of getting a number of pullets that should average at least two hundred or more eggs.

Male 2240, being a full brother of 2227, and having proven himself an inferior breeder, would be discarded.

As a matter of fact Male 2227 has a fault, in that his daughters do not lay eggs of good size and colour, and the breeder might consider seriously mating 1518 who does produce pullets laying eggs of good size and colour, in preference to Male 2227; or a cockerel from Hen H 12 bred to the daughters of 2227 would be a mating worth serious consideration.

The remaining hens, if one were short of breeders, could be tested another season by mating these to different males, but one is not likely to get daughters of a very high average from them. It is likely that one will test hens like H 46, that have laid two hundred and sixty eggs, with several males in an effort to find a male with which she will produce daughters her equal or better. Occasionally one is successful.

Our experience has been that by breeding from what appear to be the best sons of the good breeding hens a little progress is made from year to year, whereas the use of a male, simply because his mother was a high layer, may result in a decrease in production.

Pedigree breeding and progeny testing take considerable time and necessitate accurate records. Where one desires to buy males or females from such stock the purchaser should expect to pay a higher price. The labour involved in pedigree breeding, if well done, will double the cost of the ordinary chicken.

Considering that many are interested in what happens when an ordinary hen is bred to a male such as 2240 from a fairly good hen, the following results from such a mating are given:

Hen 114 laid one hundred and twenty eggs in her pullet year and five of her daughters were trap-nested with the following results:

K 261 laid 156 eggs

K 263 " 221 "

K 365 " 135 "

K 453 " 135 "

K 489 " 147 "

The average of the group was 158.8 eggs.

Experience has demonstrated many times that with reasonable care and feeding, egg production of one hundred and fifty eggs or even better can be secured by using sons of two hundred egg hens. However, to secure a flock average of one hundred and eighty to two hundred or more eggs, from a flock of three hundred to one thousand birds, requires careful breeding.

Where one wishes to establish lines for longevity it is necessary to breed two or three year old males to hens of similar age or older. In such case it would be necessary to do the breeding in late March or April as old males will not breed satisfactorily in the cold weather.

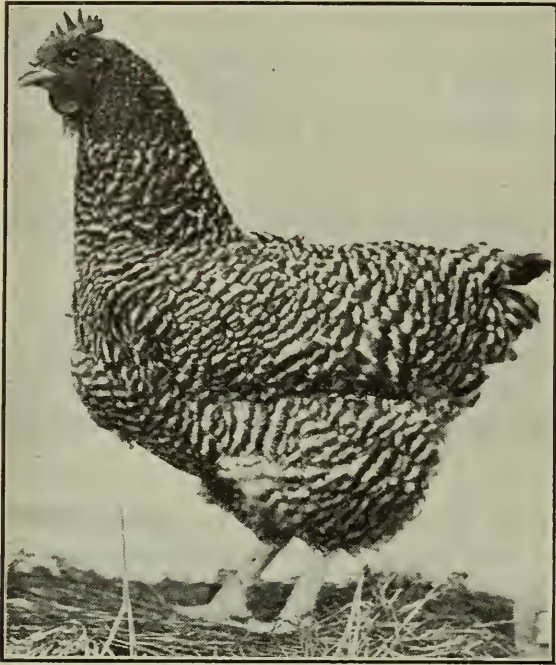


Fig. 23. H69 laid 249 eggs in her pullet year.

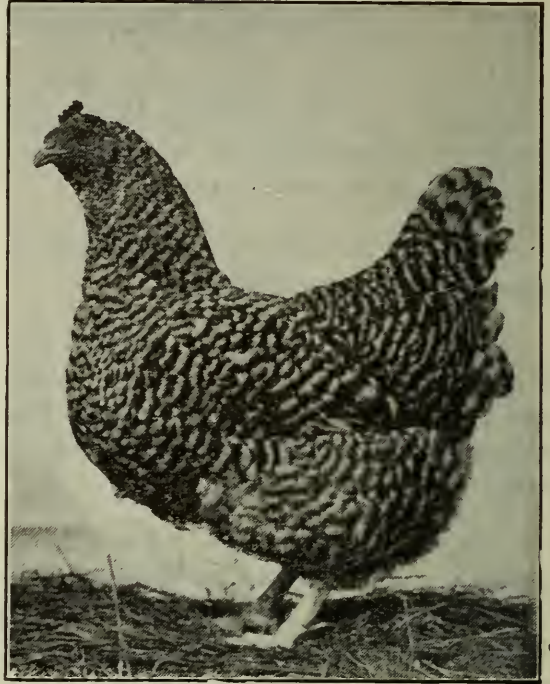


Fig. 24. K182 laid 220 eggs in her pullet year, 198 in her second year.

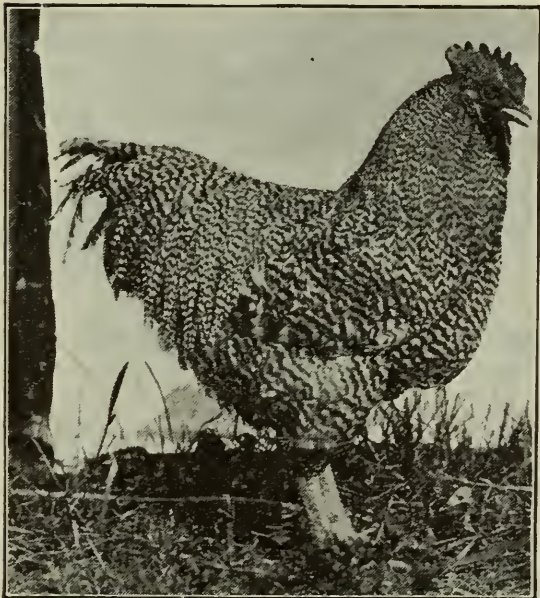


Fig. 25. L48-L49 is a son of H69.



Fig. 26. M1039-M1040 is a son of K182.

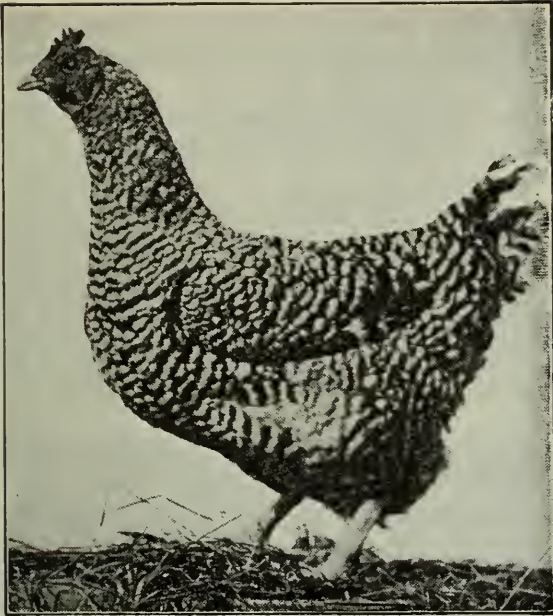


Fig. 27. H19 laid 262 eggs in her pullet year.

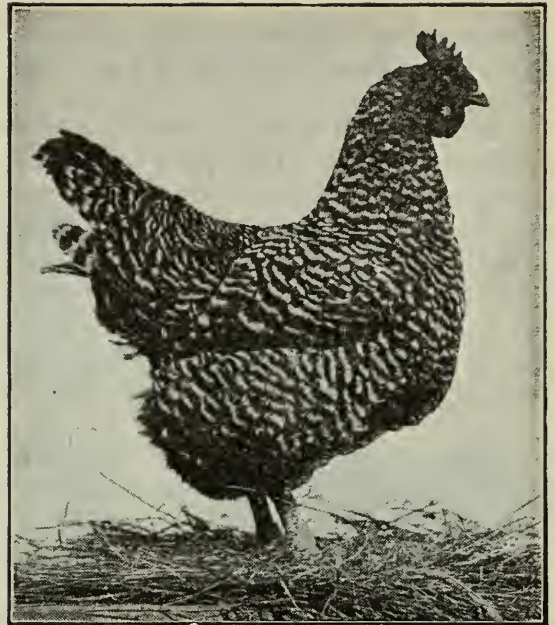


Fig. 28. K186 laid 271 eggs in her pullet year.

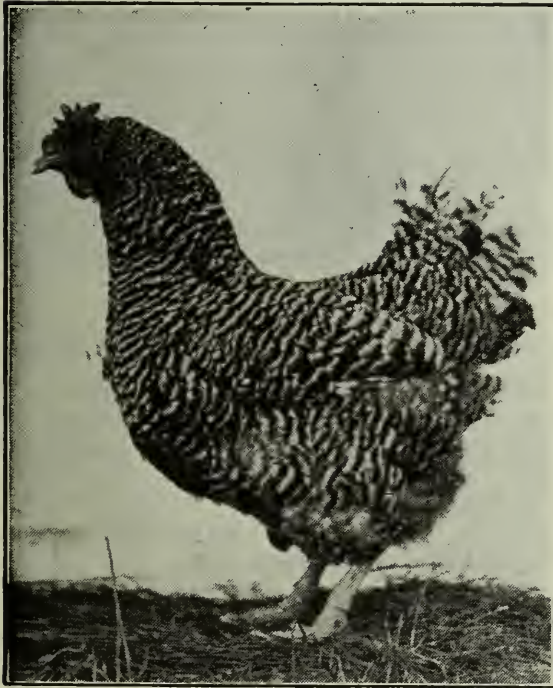


Fig. 29. K1801 laid 253 eggs in her pullet year, 196 in her second year.

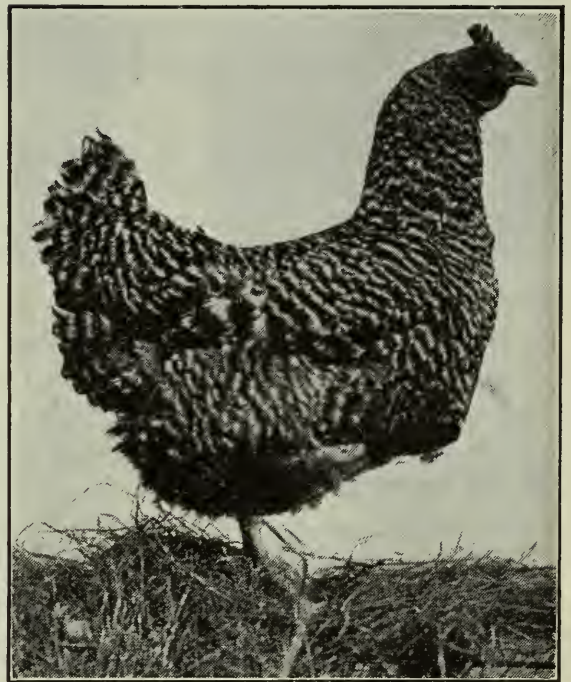


Fig. 30. G29 laid 202 eggs in her pullet year, 194 in her second year, 180 in her third year, 143 in her fourth year.

BREEDING MARKET POULTRY

There has been a tendency during recent years in selecting and breeding for high egg production to overlook the importance of market poultry. The records of the Poultry Breeding Station flocks over the past six years would suggest that the majority of flock owners are securing a larger annual revenue from market poultry than they are from eggs.

Depth of body, from the top of the back to the bottom of the keel, has been

emphasized as indicating capacity in a laying hen or breeding male. In many cases birds were selected with deep keels, but narrow bodies, and very poor breast fleshing.

Body capacity is extremely important but one should avoid narrow bodied, deep, bare keeled birds. The front end of the keel must be free of a sharp bare point, as it is impossible to cover this in fattening. Such birds are also more susceptible to bruising of the keel, resulting in abscess formation and thereby seriously reacting on the bird's market value. It is important to see that the lower edge of the keel blends in as smoothly as possible with the fleshing of the breast. Such a bird when fatted and dressed will present a smooth, round, plump carcass. Selection of this type of breeding bird need not react on the bird's egg producing qualities as it is still possible to secure in such birds good body capacity, due to length and spring of rib.

Rate of feathering in the chicks is important as the rapid feathering strain will show less pin feathers on dressing than a slow feathering strain and hence is easier dressed. Feeding will, of course, affect this condition but breeding selection is nevertheless important.

POULTRY CULLING

Weeding Out the Unprofitable Layer

A hen's appearance and handling qualities change in relation to whether she is in laying condition or not.

When a hen is laying, or approaching laying condition, the colour of the comb brightens, the skin becomes soft and loose, and the bird generally appears more thrifty and active. Many good laying hens when out of production, due to season moulting or unfortunate management, etc., may have the general appearance of a poor laying hen.

It is therefore well to keep in mind that the sorting of hens into groups of poor and good layers is best done when the birds are laying reasonably well. The characters used indicate quite easily whether the hen is laying or not and give considerable information as to the probable number of eggs the hen has laid in the past few months.

How to Hold and Handle Birds in Culling

The amateur poultryman often experiences considerable inconvenience in handling birds, and often causes the bird much worry. Fig. 31 shows the proper



Fig. 31. Method of holding bird.

way to hold a bird. The hen, when held in this way, with the breast resting on the arm, and with one's first finger between the hocks, and the thumb and second finger used to grasp the upper shank, will rest quietly and give one a chance to examine the various points to be considered.

Head Types. The head tells an interesting story. It is an index as to what may be expected in the body type and in the performance of the hen. The head should be clean cut, of medium size, not too long or crow-headed, and not too short and bunt. The crow-headed type is an indication of low producing ability, and often a lack of vigour. The short, beefy head indicates a sluggish type and is often correlated with a predisposed tendency to fatten, and with low egg production.

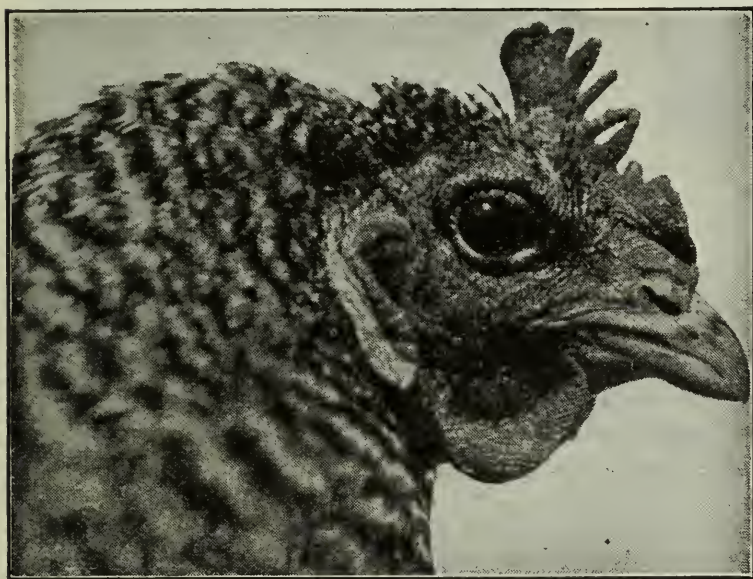


Fig. 32. Side view of good head.



Fig. 33. Front view of good head.

The illustrations show several interesting features in heads. Figs. Nos. 32 and 33 show heads with abundance of character. Note the well-turned beak, the fine texture of skin about the face, and the bright, prominent eyes set well back in large, oval eye sockets. The eyes are set close to the top of the skull with their long axes parallel with the line of the top of the skull and the beak. Note the absence of beefiness or wrinkles over the eyes and about the face. The top of the head is inclined to be flat and fairly wide. This width is carried well forward towards the nostrils. The line made by the top of the beak and skull is straight, thus avoiding an undesirable tendency to dish at the nostrils. The comb is waxy and bright. Both heads show marked indication of vigour, strength, activity and quality.

Compare these heads with those shown in Figs. 34 and 35. Here, on the one hand, is shown the rather round, narrow skull and long pointed beak of the too-refined bird. On the other hand is the head with wrinkles of fat over the eyes and a coarse skin about the face. The full, sluggish eyes are set in close, rather round sockets, not so close to the top of the head nor are the long axes of the sockets as parallel with the top of the head. These heads do not show the strength, character nor quality exhibited by the heads of the previous two birds. One should avoid extremes.



Fig. 34. Side view of poor head.
(Crow head.)



Fig. 35. Side view of poor head.
(Fat head.)

Body Conformation. The type can easily be ascertained by handling. Holding the bird as described above, take the other hand and place the thumb over the middle of the back and let the fingers fall along the side of the bird to determine the length and spring of rib. Here are located all the vital organs such as the heart, lungs and digestive organs which must function efficiently, to assist in producing eggs and in repairing worn out body tissue so that the bird can stand the wear and tear of heavy production.

If the hen is to develop speed as a layer these organs must have room in which to operate. Thus we find that the hen must possess good spring of rib and a deep, flat side. Fig. 36 shows the difference in the length and spring of rib in high producing hens as compared with low producers.

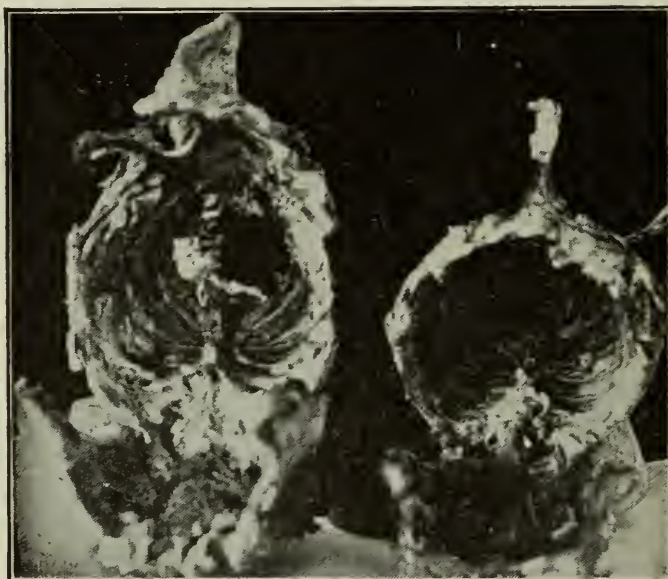


Fig. 36. Rear view of skeletons.

Note the deep, flat side of the high producer, and the round, shallow body of the lower producer. This can be determined by handling as described above.

The back should be of good length and with good width carried well out from the hips to the pubic bones. Note Figs. 37 and 38.



Fig. 37. Broad, flat back, carrying its width to the tail.



Fig. 38. Rounded back, forming a wedge with the tail.
(Poor type.)

The shape of the keel bone is important. It should run back either parallel with the back or slope downwards. It must be long to support the abdomen, or egg sack. In high producers the keel frequently has a decided hook, or downward turn, at the rear end. This is a good feature and, while not always found, is generally a sign of early and persistent production in the early part of the pullet year. The undesirable type of keel is one which tends to turn decidedly upward toward the vent and birds having such keels are often described as being canoe keeled.

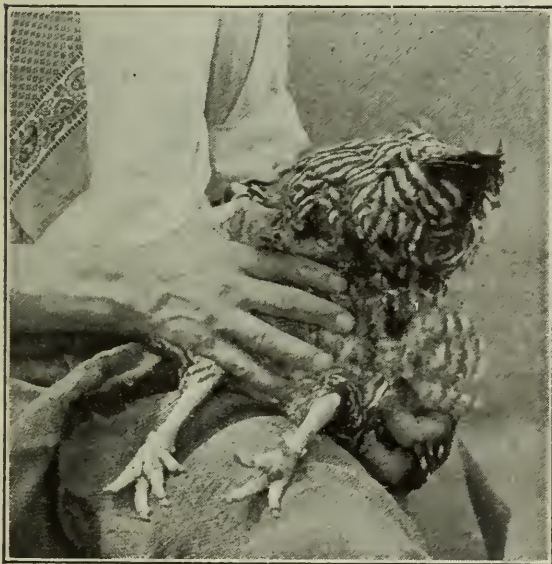


Fig. 39. Good capacity—239 eggs.



Fig. 40. Poor capacity—67 eggs.

In order to determine the capacity of the the egg sack the hand can be placed at the rear of the bird, as shown in Fig. 39. The lower finger can readily find the position of the end of the keel, and the first finger the position of the pubic bones. These pubics are two thin bones projecting out one on each side of the vent and just above it. The measure of the distance from these bones to the end of the keel is called the capacity and is spoken of in terms of the number of fingers one is able to insert.

Fig. 40 shows a poor producer with a canoe keel and only a two finger capacity. Compare this with the hen shown in Fig. 39 having more than a four finger capacity, and note the relation of this capacity to the production of the birds.

The capacity of a hen is now always the same. If the ovary is dormant and no eggs are being manufactured the capacity will be rather small. However, as soon as ovulation commences the distance between the pubic bones and the keel begins to increase and in full ovulation, or at a hen's highest production, the capacity of the bird will be the greatest.

Anyone who has dressed hens will have noticed a large accumulation of fat in the abdomen of some birds. This accumulation can be determined while the hen is living by handling the flesh in the egg sack. The fat, if present, will be hard and firm. This is a sign that ovulation has ceased and that the hen is now using her feed supply to lay up body fat instead of for the production of eggs. If a hen has accumulated a quantity of hard fat in the abdomen it is an almost certain indication that her laying days are about over. It is about time that her stay in the flock is terminated and that she should be sent to market.

Handling Qualities. This term refers chiefly to the quality of the skin in the egg sack. As noted above, there should be no hard fat. The skin should be soft, pliable, loose and elastic to the touch. It should not have a tough, hard nor leathery feel. This quality of the skin is closely related to the quality of the skin about the face of the bird. The coarse textures can be readily noticed in the face and is found to carry throughout. It is a sure sign of a lack of quality.

Shanks and Toes. Quality in some shanks is indicated in much the same way as in good horses. The legs should be flat but the bone not too fine. Often in poor type birds the legs are more angular or inclined to be round and hard. The scales of the shanks should be medium in size, fine in texture and should over-lap each other smoothly, giving the surface a kid glove finish. The toe-nails carry the index to the amount of scratching the hen is doing. A good layer is always a good worker and her toe-nails will be well worn down from scratching. This will vary with the kind of pen the hen is in. A concrete floor will wear the toe-nails much faster than will a wood or earth floor. This feature, therefore, must be compared with other birds housed under similar conditions. The colour changes in the shanks are important and will be described later.

Condition. A hen will not lay if in poor condition. She should be healthy, free from all disease and should show plenty of vigor and activity. The first pullet to lay in the Fall is the early maturing one. The pullet that is a slow grower is slow in feathering out and is also a slow layer. The condition of moult is important. Shortly after a hen commences to moult she uses a part of her feed to manufacture feathers and her egg production is lowered, or in many cases ceases entirely. Some hens moult much earlier than others. If a hen commences to moult in July her laying for the Summer is about over. It may safely be said that late moulting and heavy egg production are correlated because it gives the hen a longer period of continuous production. Such hens usually moult quickly and are again back in full feather in time for winter production. It is a peculiar fact that those birds commencing their

moult early in the Summer usually moult slowly and are often late in returning to laying condition in the Fall. The late but rapid moults frequently commence laying just as soon or sooner.

Plumage. If a hen is laying heavily the plumage will become dry, hard and brittle. The lustre will disappear and the feathers become broken. The hen certainly loses much of her natural beauty but she cannot retain that bright lustre and also keep up heavy production. Watch for the hen with a full array of feathers, all in good form, and see if she is not one of the boarders in the flock.

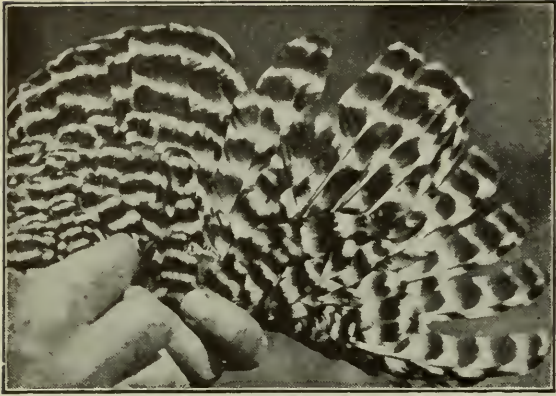
When is a Hen Laying? When the ovary is dormant and no eggs are being produced the distance between the pubic bones is very small. The vent is dry, small, puckered and in yellow fleshed birds a band of yellow pigment appears around the inner border. When laying commences the pubic bones become pliable and spread apart. The distance may increase from one to three fingers' width in a short time. The vent becomes large and moist and after two or three eggs have been laid the ring of yellow pigment has disappeared and the vent is bleached.

Further Colour Changes. The first change in pigmentation is in the yellow ring just around the vent. Two or three eggs will remove this colour. The colour then leaves the eye ring, the skin just around the edge of the eye-lid. It usually requires about six eggs, or from ten days to two weeks of production, to remove the yellow colour from this part. At about the same time the colour starts to leave the beak, commencing at the rear of the bill, and gradually fades. There is quite a distinct line of demarcation between the yellow area and the white. As laying proceeds the white area increases, gradually fading the yellow out towards the tip of the beak. When the colour is entirely gone from the beak the hen will have laid about thirty eggs, which requires about six weeks time. The shanks are the next part to show colour change. After the colour has left the beak it commences to leave the front of the shanks, the white area here also appearing and the yellow receding down the front of the shanks and from the foot up the back of the shanks, the last trace of yellow being on the back of the hock. It requires about one hundred and fifty eggs, or from five to six months of persistent production, to entirely remove the colour from the shanks. There is a difference in the rate at which this colour will disappear. Feeding plenty of green feeds tends to produce yellow colour and to prevent its disappearance. Birds closely confined during the Winter show the colour changes more plainly, and with less production, than do birds in Summer on range where they are receiving an abundance of green feed. Small sized birds for the breed, and those lacking somewhat in vitality, lose the yellow pigment more rapidly than do larger and more vigorous birds.

When the hen ceases laying the colour immediately commences to reappear. The colour first returns to the vent, then to the eye ring, a yellow area then proceeds down the beak in the same manner as the white area did previously, and this is followed by similar changes in the shanks. Any hen showing extensive pigmentation during the Spring or early Summer suggests either poor production or a prolonged rest period and such a bird should be viewed with suspicion. Short rest periods, such as broody periods, often result in a band of yellow showing in the beak, preceded and followed by a band of white.

This indicates that during the time required for the broodiness to be broken up, the bird replaced some yellow pigment, which again was followed by bleaching when laying commenced.

When a hen is broody during the Summer she usually moults one of the primary feathers in each of her wings. This moult commences next to the small axillary feather at the division of the wing. Fig. 41 shows wings outspread. The flight



A



B



C

Fig. 41. Wing Mould.

A—First primary moulted and in, second primary moulted and partly grown.

B—A pair moulted at the same time, one broody period.

C—A duplicate of A.

feathers are divided into two sections, the primary and the secondary. On her first broody period the hen may moult the first primary and a new feather will grow in. On each succeeding period of broodiness another feather may be moulted and a new one will take its place. In the illustration the hens have had rest periods, as shown by the new feathers. The complete section of primaries contains nine or ten feathers, so by counting these and taking note of any new feathers growing in, the number of rests a hen has taken can be fairly accurately determined. A hen showing a tendency to spend much of her time in brooding can well be removed from the flock as her production will not be high.

Temperament. There is much difference in the temperament of individual hens. Almost invariably the heavy layer is quite docile and does not object to handling. She will rest quietly and contentedly in one's hands while being handled. The poor layer has a disposition quite in keeping with her head type. She is wild and noisy, the quiet behaviour of the good hen being replaced by squawking on the part of the cull. These same differences can be noticed in the actions of the birds in their pens. The heavy layer is always going about, busy but contented. She is among the first off the roost in the morning and is late in going to rest at night.

The Time to Cull Hens. It is recommended that the culling be done during the latter part of April, May or early June. At this time of the year the heavy Spring production is almost over and the poorer members of the flock will soon be ceasing to lay. The meat price of hens is still good. Later on during late July and in August, the early moulters should be noted, removed and disposed of. It is, however, not necessary nor desirable to allow poor birds to remain in the flock until Spring or Summer.

The most intelligent culling programme is the one which calls for the removal of undesirable birds at any time of the year. The careful poultryman will keep a close watch at all times for outstanding boarders and immediately dispose of such. It must be borne in mind that every unproductive bird may offset the profit of a productive one, with the result that neither returns a profit to the owner.

Marketing the Culls. Where one general culling a year is done the hens can easily be graded into three classes. The good performers can be banded and left in the pen and real culls crated and sold. There are, however, a number of hens which are still laying, though of poor type and which will not be desirable birds to hold over another season. These can be temporarily marked, kept until they have ceased laying and then sold. A good method of marking these birds is to cut off their tails. This makes them easily identified when it is desirable to dispose of them.

The following chart, developed by the Poultry Department of the Kansas Agricultural College, Manhattan, Kansas, summarizes the points taken into consideration in the instructions for culling chickens.

Judging for Present Production

CHARACTER	LAYING HEN	NON-LAYING HEN
Vent.....	Large, dilated, oblong, moist.	Small, contracted, round, dry.
Pubic bones.....	Flexible and wide apart.	Rigid, close together.
Comb.....	Large, red, full, glossy.	Small, pale, scaly.
Wattles and lobes....	Prominent, soft, smooth.	Inconspicuous, rough, dry.

Judging Past Production

CHARACTER	LONG-LAYING PERIOD	SHORT-LAYING PERIOD
Vent.....	Bluish white.	Flesh coloured.
Eyelids.....	Thin and edges white.	Thick, yellow tinted.
Eye.....	Prominent, keen, sparkling.	Listless, sunken.
Earlobes.....	Enamel white.	Yellow tinted.
Beak.....	Pearly white.	Yellow tinted.
Face.....	Clean cut, sunken.	Full, well fleshed, yellowish.
Shanks.....	White, flat, thin, creased.	Yellow, round, smooth.
Plumage.....	Worn, soiled, lifeless, close-feathered.	Signs of moulting, loose-feathered.

Judging Rate of Production

CHARACTER	HIGH RATE	LOW RATE
Keel.....	Slopes downward.	Slopes upward.
Pubic bones.....	Tips thin, point straight out.	Tips thick, curved in.
Capacity.....	Four to five fingers.	Two fingers.
Abdomen.....	Soft, pliable, dilated.	Fatty, hard, contracted.
Rump.....	Broad, width carried back.	Narrow, cramped.
Lateral processes....	Prominent, pointed outward.	Hard to find, pointed inward.
Skin.....	Soft, thin, loose, silky.	Thick, dry, underlaid with fat.

MARKETING POULTRY PRODUCTS

The only fair method to both producer and consumer is the sale and purchase of eggs and poultry on a graded basis. The producer of a first-class product should get the best price and the consumer should know what he or she is buying.

The establishment of definite legal grades has changed the marketing conditions in many parts of the Province. The regulations governing the grades of poultry and eggs are under the direction of the Dominion Live Stock Branch and information relative to them will be gladly furnished to parties writing the Live Stock Commissioner in Ottawa.

Poultry and eggs are good food. For some unknown reason the average Canadian does not consume very much poultry meat. The consumption of eggs is relatively high in Canada but it has not by any means reached its maximum.

In the producing sections situated away from centres of consumption, the securing of a price commensurate with the actual value of the product, or its cost of production, is a problem. There are two factors that will assist in solving the problem; one is for the buyer, whether dealer or grower, to buy the produce on a quality payment basis; and the other is selling through co-operative organizations. Which is the better method depends entirely on local circumstances. A Co-Operative Society, situated away from large local markets, when well managed should be the better method; on the other hand payment on the basis of quality is simple and just. These problems can best be solved by the producer and dealer getting together. Co-operative buying and selling is the ideal method, but everybody must work together and stay with the organization. It is seldom that a Co-operative Society or Joint Stock Company does not have occasional poor years and unsatisfactory conditions. Success depends on united effort.

MARKET POULTRY

The production of market poultry of high quality has been a profitable business for the past few years. Some poultrymen actually derive a larger return from poultry meat than they do from eggs. This is particularly true where one develops a programme of continuous marketing throughout the year. Frequent and regular culling of the mature stock, plus the young stock in season, makes such a plan possible.

There is difficulty in marketing any produce of low grade. The market prefers a bird well fleshed, well fattened and cleanly plucked. This means that, as previously suggested, the keel blade should not be extremely deep but should be well covered with flesh. The back should show a considerable layer of fat, as well as a good covering of fat over the pin bones and around the wish-bone and breast. The best grades of poultry call for a white fat.

The mass production of broilers under crowded conditions, where little attention is given to properly finishing the birds, has seriously reacted on the general market. Undersized, poorly finished birds spoil the market for good stock and hence everyone loses money instead of making some profit. Bare-backed, crooked breasted, crooked legged chickens are not wanted on the market.

Chickens fatten fairly readily at from two pounds in weight until maturity. Where the males are caponized they fatten more easily at any age. Generally speaking, immature cockerels or birds under five pounds in weight, are comparatively easy to fatten, especially when the weather is cool. More mature males develop spurs, turn blue over the hips and are then graded as stags.

FATTENING CHICKENS

The greater quantity of poultry going on the market today is not properly fatted. The introduction of grading, and the premium price paid for milk-fed A grade should induce the producer to give more attention to the proper finishing of the birds. Chickens taken direct from the range, even where grown under the most ideal conditions, will probably not grade higher than third grade. Such birds if subjected to from two to four weeks of intensive feeding would, in many cases, grade top and, in addition, show very economical gains for the feed consumed.

Birds, to fatten efficiently, must be in good health when placed in the crates. If suffering from colds, roup, worms, or other infections or parasites, they will probably lose rather than gain in weight. Good, thrifty, slightly immature cockerels, either pure-breds, crosses or grades, of such breeds as Plymouth Rocks, Wyandottes, Rhode Island Reds, Orpingtons, Sussex, Jersey Giants, Dorkings, Games, etc., make economical gains. It is seldom profitable to attempt to feed for roasters such breeds as Leghorns, Minorcas or birds of similar characteristics, although they make fairly good broilers.

The greatest gains are made during the first two weeks of feeding. Where feeding longer it would be necessary to get a premium price in order to pay for the longer feeding and the slower rate of gain. Birds are fed three times daily.

Crate Feeding vs. Loose Pen Fattening of Chickens

The term "fattening of chickens" has been in use for some time but it does not exactly convey the meaning intended by the feeders of chickens. The object is to improve the fleshing and add just sufficient fat to make the meat cook well. The chickens are not intended to be abnormally fat, yet at the same time carry considerable fat well intermixed with the lean meat.

We have for a number of years conducted experiments with chickens in crates and in loose pens. Several feeds secured equally as good results with birds in crates as with those in loose pens. Two feeders in particular fed birds to better advantage in crates, while one feeder could get slightly better returns, although not always, with birds in pens.

The majority of buyers seem to think that crate-fed birds are much superior to those fed in loose pens. We prefer feeding birds in crates because it takes less room and we believe that we can feed them with less expenditure of labour and get a more even product.

Construction of a Fattening Crate

Fattening crates are made seven feet six inches long, eighteen to twenty inches high, and eighteen inches wide. The crates are divided into three compartments, each holding from four to five birds, depending on the size of the chickens.

The crate is made of slats, except the ends and partitions which are solid wood. The slats at the top, bottom and back run lengthwise of the coop and those on the front are vertical. The slats are one and one-half inches wide and five-eighths inches thick. Those in the front are placed two inches apart to allow the chickens to put their heads through for feeding. The slats on the bottom are placed about three-quarters of an inch apart so as to admit of the droppings passing through to the ground. Care should be taken not to have the first bottom slat at the back fit too closely against the back. An opening between the first slat and the back prevents droppings from collecting. The slats on the top and back are two inches apart.

There is a small V-shaped trough arranged in front of the coop for feeding and watering the chickens. This trough is from three to four inches deep and is made of three-quarter inch lumber. Coops may be made from old packing boxes by taking off the front and bottom and substituting slats in their place. During warm weather the crates may be placed out of doors. They need to be protected from the rain by placing a few boards over them. In cold weather the crates should be placed in a house or shed where they are protected from raw, cold winds. When fattening chickens inside of a building it is well to darken the building and keep the birds as quiet as possible.

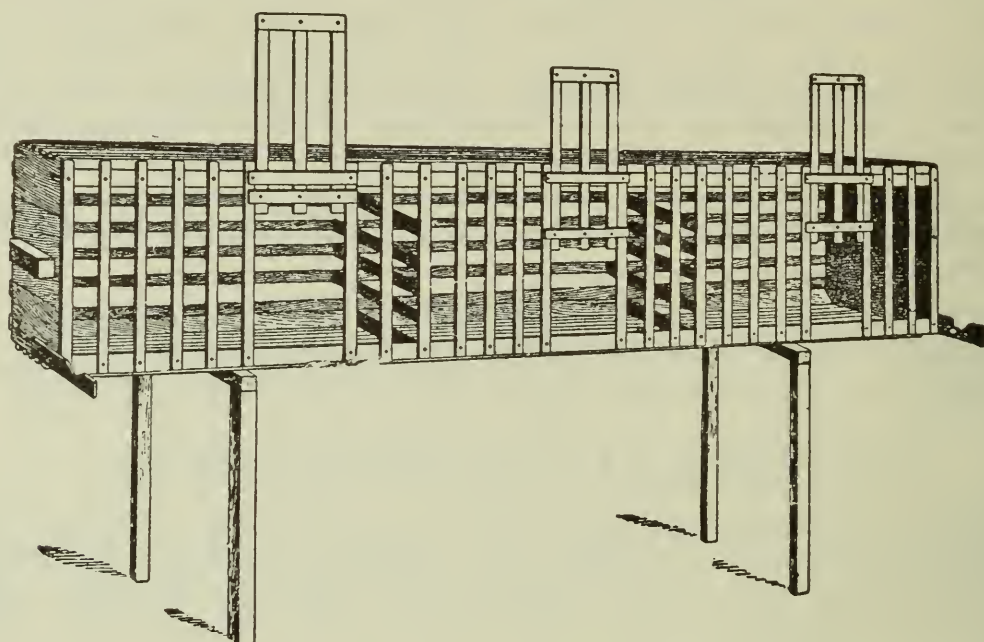


Fig. 42. Showing a single crate or coop.

After each lot of birds is killed the crates are painted with some liquid lice killer. Coal-oil and carbolic acid are very good. Use one gallon of coal-oil to one pint of crude carbolic acid. We have used some of the prepared mixtures with good results. If the birds are lousy when put in they should be well dusted with Sodium Flouride, or other insect powder. Some people use sulphur but when this material is used care should be taken not to use too much as an excess may produce a scaly condition of the bird's skin. Lousy birds do not fatten economically and are unpleasant to pluck, Dust again twenty-four hours before killing.

The birds should be watered at least twice every day in warm weather. Grit should be given them twice a week.

How to Feed

We have received a number of enquiries as to how to feed birds that are being fattened, and the exact amount of feed to give each day. In answer to these enquiries, a sample feeding schedule is here given.

Birds brought in from the range should be starved for about twenty-four hours, during which time water may be given. They must be fed lightly at first, giving only what will be eaten up in about ten minutes. As the amount fed is increased the time for feed is also increased until at the end of the feeding period they are allowed from twenty to thirty minutes in which to feed. Any feed left in the troughs after the specified time should be removed.

Table No. 24 shows amounts fed morning and evening to two lots of four birds each. The first lot shows steady increase in amount fed, while the second shows irregular increase.

TABLE No. 24

LOT No. 1					LOT No. 2				
Dates	Morning		Evening		Morning		Evening		
	Meal	Milk	Meal	Milk	Meal	Milk	Meal	Milk	
Oct. 10..	oz.	oz.	4.25 oz.	6.25 oz.	oz.	oz.	5.0 oz.	7.5 oz.	
" 11..	5.0 "	7.5 "	5.5 "	8.25 "	5.0 "	7.5 "	6.0 "	9.0 "	
" 12..	6.0 "	9.0 "	6.5 "	9.75 "	6.5 "	9.25 "	6.0 "	9.0 "	
" 13..	7.0 "	10.5 "	7.0 "	10.5 "	6.0 "	9.0 "	5.5 "	8.25 "	
" 14..	7.0 "	10.5 "	7.0 "	10.5 "	6.0 "	9.0 "	6.5 "	9.25 "	
" 15..	7.5 "	11.25 "	7.5 "	11.25 "	6.0 "	9.0 "	5.5 "	8.25 "	
" 16..	7.75 "	11.75 "	7.75 "	11.75 "	6.0 "	6.0 "	6.0 "	9.0 "	
" 17..	8.0 "	12.00 "	8.25 "	12.00 "	6.5 "	9.25 "	7.0 "	10.5 "	
" 18..	8.5 "	12.25 "	8.75 "	13.00 "	8.0 "	12.00 "	8.0 "	12.0 "	
" 19..	9.0 "	13.50 "	9.25 "	14.00 "	8.0 "	12.00 "	9.0 "	13.5 "	
" 20..	9.5 "	14.25 "	9.75 "	15.75 "	10.0 "	15.0 "	10.0 "	15.0 "	
" 21..	10.0 "	15.00 "	10.25 "	15.25 "	10.0 "	15.0 "	9.0 "	13.5 "	
" 22..	10.5 "	15.50 "	10.75 "	16.00 "	9.0 "	13.5 "	9.0 "	13.5 "	
" 23..	11.0 "	16.50 "	11.25 "	16.75 "	10.0 "	15.0 "	8.0 "	12.0 "	
" 24..	11.25 "	16.75 "	12.00 "	18.00 "	10.0 "	15.0 "	10.0 "	15.0 "	

It is difficult to give a ration suitable for fattening chickens that meets the requirements of every individual. One has to use whatever feeds are available and for that reason we are giving several rations that have generally proven satisfactory. The grains in a ration should be ground as finely as possible and mixed with milk to the consistency of a pancake batter, so it will pour. Usually better results are secured when the feed is mixed twelve hours prior to feeding.

It is of the utmost importance that the birds be kept with keen appetites as a little over feeding at the beginning usually results in indifferent gains.

Fattening Rations

Equal parts, by weight, of ground oats (with the hulls sifted out, or ground oat groats, or oat middlings), white hominy and ground wheat. This is mixed with thick, sour milk, or where milk powder is used add twenty per cent to the grain mixture.

The hominy and oats improve the palatability of the ration and help in the production of fat. Meat meal may be used in the place of the milk but does not produce as good colour of fat, nor as satisfactory gains.

Another very good ration is composed of two parts of finely ground oats, two parts finely ground buckwheat and one part of finely ground corn, moistened with sour milk.

The ration we are using at present, with very good results, is composed of 100 pounds white hominy, 50 pounds each of ground barley, oats and wheat. To this 250 pounds we add 36 pounds of powdered milk, about 2 pounds charcoal, and $\frac{1}{2}$ pound of salt. This is moistened to rather a wet state, but not sloppy, and is fed what the birds will eat up clean in fifteen minutes.

Any feeds that are palatable and well mixed, so that the meal will stay in suspension with the milk, will give, in most cases, reasonably good results. It is not advisable to use only one kind of cereal.

KILLING AND DRESSING POULTRY

All birds should be fasted for twenty-four hours before killing, and during the period of fast be given some water to drink. If this is not done any feed remaining in the crop and intestines at the time the bird is killed decomposes. As a result of this decomposition, strong smelling gases are liberated which taint the flesh of the bird, not only destroying its flavour, but very seriously lowering its keeping qualities.

All birds should be killed by bleeding, preferably through the mouth. This is a very simple operation and a little practice will ordinarily make one fairly proficient at this work. Two general methods of handling the birds are used; the one is to place the bird on a padded bench or table, and the other is to hang the bird up by

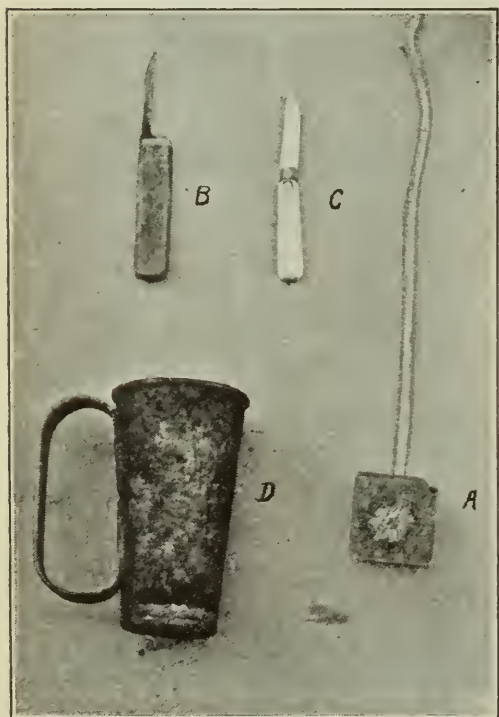


Fig. 43. Killing and Plucking Equipment—(a) Rope and block for hanging bird up; (b) Killing knife; (c) Pinning knife; (d) Weighted blood cup.

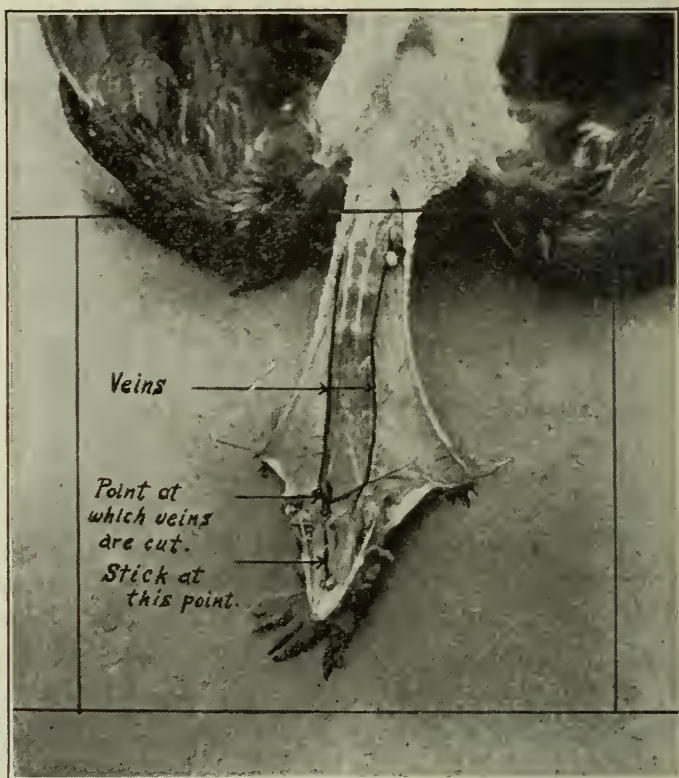


Fig. 44. Anatomical view of neck showing the location of veins, also the cleft in the roof of the mouth where bleeding and braining operations are performed.

the feet with a rope or cord. For the average person the latter method is preferred as with it there is less danger of bruising or barking the skin than where the bird is lying upon some object. The one end of the rope or cord may be fastened to a small rod or pole and to the other end is attached a small block about two inches square, as shown in Fig. 43, A.

When hanging the bird up, the end of the rope which is attached to the block is placed around the feet and the block dropped in between the bird's feet and the rope. This holds the bird without tying and should be so adjusted that the bird's feet are about on a level with the picker's shoulders.

For bleeding, a sharp knife with a blade about three inches in length is most satisfactory. A regulation killingknife is shown in Fig. 43, B. To bleed, catch the bird's head with the thumb and forefinger just at the juncture of the neck and head, or at the ear-lobes as shown in Fig. 45, then with the third finger open the chicken's

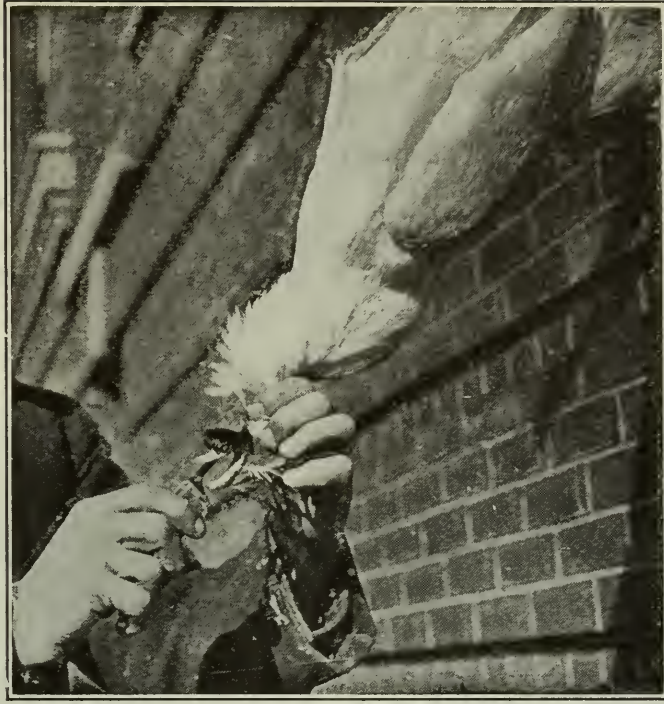


Fig. 45. Bleeding operation.

mouth. Next insert the knife and pass it down the throat practically the full length of the blade, then with the edge of the blade turned downward, cut rather heavily with a drawing stroke of the knife. The object is to sever the jugular veins at the point where they unite at the left side of the throat, as shown in Fig. 44.

The bird should bleed freely if the cut is made at the proper point. Next, turn the blade of the knife over and insert the point of the blade in the slit or groove in the roof of the mouth, as shown in Fig. 44, and then quickly push backward so as to pierce the brain. If the back of the knife is kept in a line with and touching the point of the bill, the blade will pierce the brain. One can tell when this is done because the bird will squawk. If it does not squawk the brain is not pierced, which means tight feathers and hard plucking. As soon as the sticking operations are completed attach a blood can at the lower bill. This catches the blood, thus preventing it being thrown about, and the can being weighted tends to hold the bird still. For a blood can any small can to which a hook can be attached will answer the purpose. In Fig. 43, D, is shown a style of blood can which is used extensively in the packing houses. In this can the hook is solidly attached on the inside, near the handle. The can is weighted with three-quarters of an inch of lead in the bottom. Cement or a small stone will answer the purpose just as well.

The chicken should be plucked immediately, first removing the long wing feathers and tail feathers, then the feathers on each side of the breast, those on the legs, and lastly those on the back. Do not try to pull the feathers either forward or backward, but somewhat sideways or at an angle. The rough or coarse feathers should be removed in the shortest time possible, as the more quickly the feathers are removed after sticking the easier they will pull and the less danger there is of tearing the skin. In removing the wing feathers for instance, grasp both wings in the left hand and the feathers of both in the right, removing them all at one stroke of the right hand. Next, raise the right hand to the tail, grasping tightly all the feathers in the tail, and with a slight twist remove with a second stroke of the right hand, and so on over the different sections of the body. To remove the pin feathers use a dull bladed knife, similar to an ordinary paring knife, Fig. 43, C. Be careful not to rub

or bark the skin. This may be done very easily by rough handling, or by placing the chicken in contact with coarse clothing, hence do not place the chicken on your lap to pluck it. If you should unfortunately tear the skin, hold the skin at the torn part tightly to the body between the thumb and first finger, and then remove the rough feathers near the torn spot. Anyone, with a little practice, can entirely remove the rough feathers from a bird in from three to five minutes. Expert pluckers will do it in from three-quarters of a minute to one minute.

The bird should be plucked clean, the blood washed from the head and out of the mouth, and the feet washed clean.

The cooling rack, Fig. 46, allows free circulation of air around the birds, resulting in more rapid cooling, which in large packing plants is very important. In such places we find the cooling rack in common use.

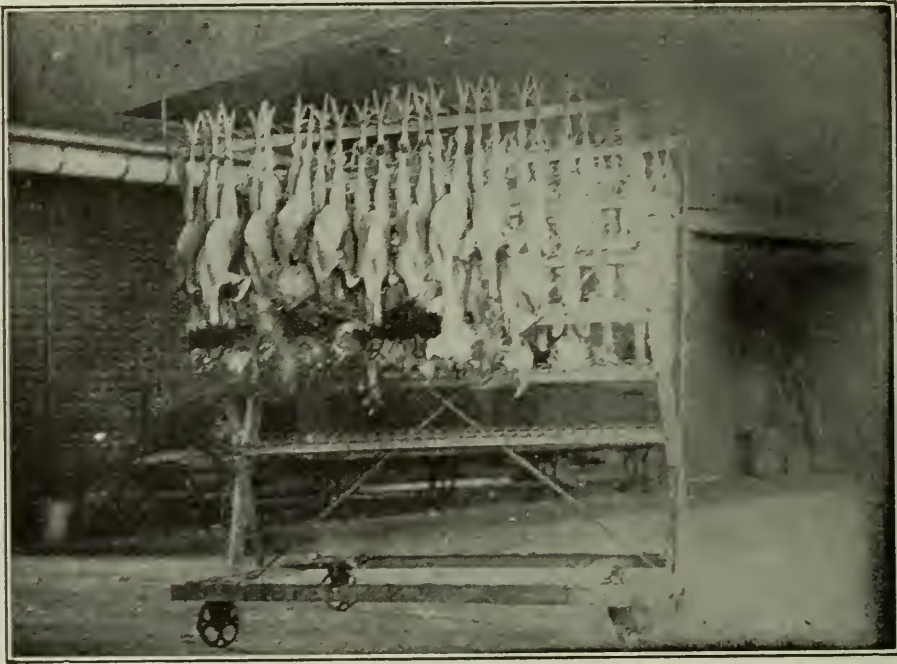


Fig. 46. Cooling Rack.

Many good chickens are spoiled by being packed before they are thoroughly cooled. Care should be taken to see that all the animal heat is out of the body before they are packed. We find it advisable to cool the birds at least twelve hours before packing them.

In packing for shipping, they should be packed in boxes holding one dozen birds to the box. The size of the box varies with the grade or size of chickens placed in them, but should be such that when the chickens are packed they are absolutely tight so that there is no possibility of them shaking about and becoming bruised. The boxes are best made of basswood or similar wood, free from odour, as otherwise the flesh of the birds will absorb the odour, tainting the flesh. The box is lined with parchment paper and, if the chickens are to be shipped a long distance, each bird is also wrapped in parchment. This prevents the chickens bruising each other and, at the same time to a considerable extent, checks decomposition. Do not use ordinary wrapping paper as it absorbs dampness and will cause the chickens to become clammy, which makes them unsaleable.

The dimensions of some of the boxes are: For broilers weighing about 24 lbs. per dozen, 16 inches by 15 inches by $3\frac{1}{2}$ inches, inside measurement. This is where

they are packed in single layer with the breast up and the legs extended. For chickens weighing thirty-six to forty-two pounds per dozen a box 23 inches by 15½ inches by 4 inches, inside measurements, would do. For one dozen roasters weighing four to four and one-half pounds each, a box 32 inches by 19 inches by 4 inches, inside measurements; and for heavy roasters weighing five to five and one-half pounds each, and packed single layer, a box 33 inches by 20 inches by 4½ inches, inside measurement. The material used varies in thickness from one-quarter inch for sides, bottom and top, and one-half inch for ends in the smallest size boxes, to one-half inch for sides, top and bottom and seven-eighths inch ends in the largest boxes.

(The writers wish to acknowledge the use of POULTRY PACKERS' GUIDE in preparation of box dimensions above stated, for which credit is hereby given.)



Fig. 47.



Fig. 48.

Showing Good (47) and Poorly Fleshed (48) Birds.

MARKET EGGS

There appears to be a general idea that the shell of an egg protects the contents against all kinds of contamination and temperature variations and that while the outside of a shell may be dirty the interior is not affected by such conditions. Such an idea could not be farther from the facts.

Factors Affecting Egg Quality, Flavour and Palatability

Eggs are a very perishable food—just as perishable a food as milk. Perhaps we do not realize this because nature gives us eggs already done up in a package, the shell, and we cannot see the deterioration taking place as we can in other foods. But this container, the egg shell, is of a porous material and as a result air can readily pass through it, evaporation may take place or strong odours may penetrate it and affect the flavour of the egg.

Milk deteriorates quickly if left around at ordinary room temperature of 70 degrees F. This is also true of eggs. Eggs will rapidly deteriorate in palatability, in flavour and in poaching qualities if left at such a temperature.

The following tests, made at the Macdonald Institute in co-operation with the O. A. C. Poultry Department, definitely show how the egg declines in palatability

under unfavourable conditions, and how a strong odour may affect the flavour of an egg.

Some eggs were kept in a refrigerator at 50 degrees F.; some were left at room temperatures (which ranged from 69 to 76 degrees F.); and some were exposed to a strong tar odour. These eggs were tested frequently for:

1. Flavour—by cooking the egg in the shell, chipping off the top and testing the egg as soon as it was cooked;

2. Poaching Qualities—by poaching the egg. The flavour of these eggs was also noted.

The following are the results of these tests:

THE EGG AND ITS TREATMENT	RESULTS OF THE TESTS FOR	
	FLAVOUR	POACHING
Fresh May eggs, exposed to a strong tar odour, tested when less than 24 hours old.....	Strong Tar Flavour, especially in yolk	Excellent appearance but a strong tar flavour
Tested when 5 days old.....	Still a strong tar flavour	
Fresh May eggs, held in refrigerator at temperature of 70 degrees F....		
1 day old.....	Excellent	Excellent to good
2 " "	Excellent	Excellent to good
3 " "	Good	Good
5 " "	Good	Good
6 " "	Good to fair	Fair to good
9 " "	Fair	Fair
10 " "	Fair	Poor
Fresh May eggs, held in refrigerator at temperature of 50 degrees F....		
1 day old.....	Excellent	Excellent
2 " "	Excellent	Excellent
3 " "	Excellent	Excellent to good
5 " "	Excellent to good	Excellent to good
6 " "	Excellent to good	Excellent to good
9 " "	Excellent to good	Good
10 " "	Good	Good

Putting the whole thing into a nut shell, these are the facts:

1. Strong odours will pass through the shell and spoil the flavour of eggs;

2. The longer eggs are held, the GREATER the decline in flavours and poaching qualities;

3. The higher the temperature at which eggs are held, the more RAPID the decline in flavour and poaching qualities.

It is very desirable that eggs for household use have good flavour and poaching qualities since the homemaker uses eggs so much for table purposes. According to a very limited amount of data which we have collected by means of questionnaires

(questionnaires were sent out through the Home Economics classes of the Consolidated School and the Guelph Collegiate and Vocational Institute) more than two-thirds of the eggs used were for table purposes—boiled, poached, raw in drinks, fried, scrambled or in omelettes—purposes which necessitate the use of an egg of good flavour and poaching qualities in order to obtain satisfactory results.

And so, whether you be a producer of eggs, a dealer, or a consumer, why not give the eggs the care which you give any other perishable food? Keep eggs in a cool place, free from all odours, just as you do milk, butter, etc. The producer will find such precaution well worth while since it helps preserve the quality of his product. The dealer will also find it to his advantage to give eggs proper care so that his customers will be pleased with the quality of such eggs and will come back for more. It is also advisable for the consumer to keep eggs in a cool, clean place in order to preserve the palatability of the eggs from the time they reach the kitchen until they are used.

Other Conditions Affecting Egg Quality

The shell of the egg being porous, we can readily understand how minute animal and plant life may enter the egg shells. For example, egg cases with the fillers, flats and pads may get wet and as a result mould develops. Later eggs are placed in such cases and left for a time with the result that when the eggs are removed, in addition to them having a musty odour and taste, mould growth may actually be found on the inside of the shells.

Many eggs are spoiled by being partially incubated. Most people believe that an egg must be set under a hen or in an incubator before it will commence to hatch. A temperature over seventy-five degrees F. will start embryonic development. Eggs are frequently exposed to higher temperatures for hours and even days in warm weather before they reach the consumer. If such eggs are later subjected to temperatures under sixty-five, the developing embryo dies and the egg is unfit for food. There are numerous ways in which hatching may be started in eggs. Failure to collect eggs frequently during the warm weather, or leaving them over night under broody hens, are common causes, also leaving eggs exposed to the sun or in warm rooms, stores, cars, etc., or even having them in a warm kitchen cupboard.

Removal of the male birds from the flock in warm weather, resulting in the production of non-fertile eggs, would very materially reduce the present losses from partially hatched eggs.

Holding temperatures are also of great importance in preventing loss of quality and a consequent lowering of grade.

Dirty eggs, or even washed eggs, may go bad or be rendered unfit for food due to these conditions. The washing of eggs is not so objectionable if the eggs are used immediately but they deteriorate very rapidly after washing.

The feed that a hen consumes may very materially affect the flavour of the eggs laid. Hens that are forced to forage for most of their living during the summer may produce eggs in which the yolks are dark in colour and strong in flavour. However, hens fed on a properly balanced ration and freely exposed to direct sunlight, produce eggs of good quality that may be considered of superior nutritional value.

POULTRY HOUSING

The proper housing of poultry is an essential factor of success. This does not necessarily mean heavy expenditures or elaborate structures; in fact it is usually found that the cheaper and simpler houses are the more efficient. The type of building is apparently not so important, as one may find a wide divergency of types giving equal efficiency and economy of operation. It is therefore not proposed to lay down any hard and fast rule relative to the type of building, but rather to discuss some of the fundamental principles underlying successful housing.

In order that one may get a true perspective of the whole question it is first necessary to give some thought to the question of location and to the primary essentials in housing. There are two general classes of poultry houses: those used for laying and breeding purposes and those used for rearing. The former are usually on permanent foundations, while the latter are mostly portable. The variation is mainly one of size or type. In order to avoid the possibility of confusion in the mind of the reader, the laying or permanent house will be discussed first.

Location of Laying or Breeding Houses

Convenience: Locate the houses near the source of supplies. Whether the number of birds to be kept is large or small there will be a considerable amount of feed to transport, hence the nearer to the source of supplies, with due consideration to equally important factors, the greater will be the saving in time and labour.

Exposure: The house should be built facing the South or South-East, if possible, as such an exposure will give the maximum amount of sunlight in the pens. There is also greater protection from the prevailing winds, which are usually from the North or North-West. Full advantage should be taken of any shelter (either natural or artificial) from the prevailing winds as the birds do not take kindly to an exposed location. Bird comfort is closely associated with economic production and any condition which will make the bird more comfortable should receive full consideration.

Soil: The type of soil and the lay of the land are influencing factors in drainage. The ideal soil is one which is slightly rolling and open in texture. Heavy soils, especially those with a hardpan sub-soil, drain poorly at best and hence are unsatisfactory. A damp soil harbours disease.

Drainage: Drainage about the poultry house and yards is of extreme importance. Poorly drained yards aggravate trouble from dampness in the house and yards. There is also a manifestly increased amount of trouble from diseases and intestinal parasitic infestation under such conditions.

Shade: Extremes of temperature lessen production and should be modified in so far as practicable. Dense Summer shade, however, as from the heavy foliage of trees, shrubs or bushes, is not desirable. Such locations do not benefit from the germicidal action of direct sunlight and hence may serve as sources of infection of disease and parasites.

Laying or Breeding Houses

Types of Houses: There are two main types of laying houses in general use, i.e. the long or continuous house divided into two or more pens, and the single pen house. Two storey and multiple deck houses are also being used by some poultrymen. There are many points in favour of each of these types, as well as some objections to each. The long house is, no doubt, more economical to construct than the single

pen house and requires less labour to operate. If separate matings are necessary, yards are required, which mean added expense and close confinement for the birds. The single pen house, while costing more than the continuous type, permits of spreading the birds over a large area, making it possible to dispense with yards, and less trouble is likely to be experienced with disease and loss of vigour in the flock. The greatest objection to this latter method of housing is the extra labour required to care for the stock.



Fig. 49. Double-deck house, showing the arrangement and type of window, also ventilating opening above the windows as used in the Sanctuary system of ventilation.—(Courtesy of W. S. Hall).

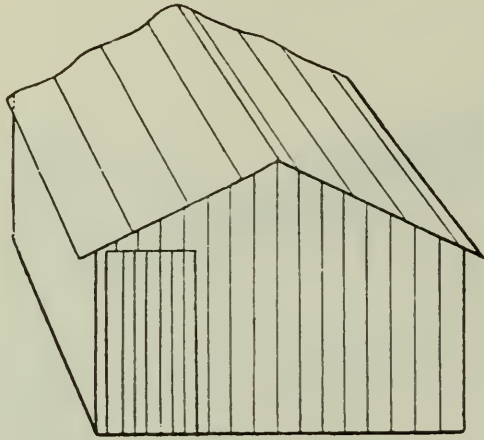
The two storey house allows the same roof and foundation to provide double the housing capacity of a single storey building, with additional cost for these items. It also is a more compact structure and the labour requirement is reduced. (See Fig. 49). Two-by-six inch studs are required for strength and a gable roof covered with a good grade of asphalt or wood shingles is desirable. The window and dropping board arrangements for both upper and lower floors may be similar to those shown in Figs. 49, 61 and 63. There are a number of farms on which an unused loft or mow may be easily remodelled into satisfactory pens of one or more storeys. It is usually necessary that the birds on the upper floors remain confined throughout the year.

The Primary Essentials in Housing

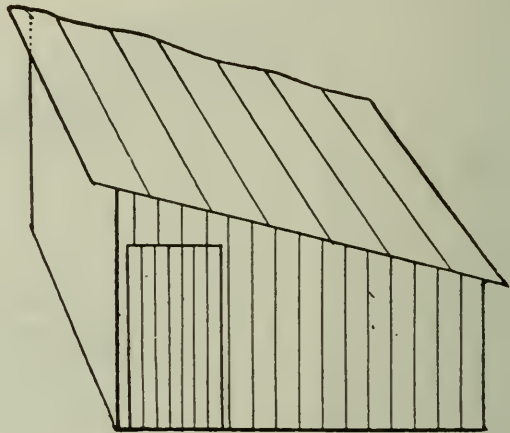
The main essential in housing is bird comfort. The major factors in providing this condition are: (1) floor space; (2) light; (3) dryness; (4) freedom from draughts; (5) ventilation.

(1) Floor Space: Over-crowding is a common fault. The practice reacts adversely upon every phase of production and predisposes the birds to disease. The floor space requirement determines the capacity of a pen or building and it is

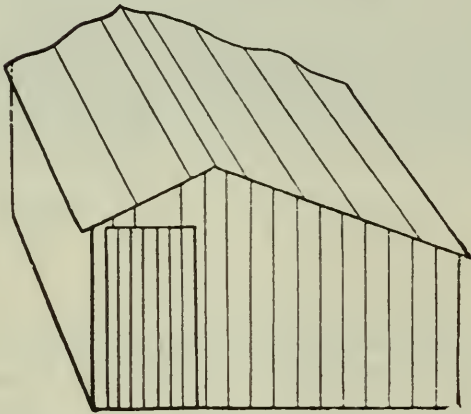
therefore necessary to carefully determine the capacity of the pen and then regulate its population accordingly. Floor space requirement will vary with the size of the pen, the type of building and the breed of birds. In small pens the floor space allowance is greatest, being possibly as high as six square feet per bird. Increasing the size of the pen permits a reduction in the per bird floor space requirement, with a minimum in even the largest pens of four square feet. The more open the building and the smaller the breed of fowl, the greater is the capacity of a given house or pen. The per bird cost of construction is important. This should be kept as low as possible, consistent with the adequate provision of the essentials.



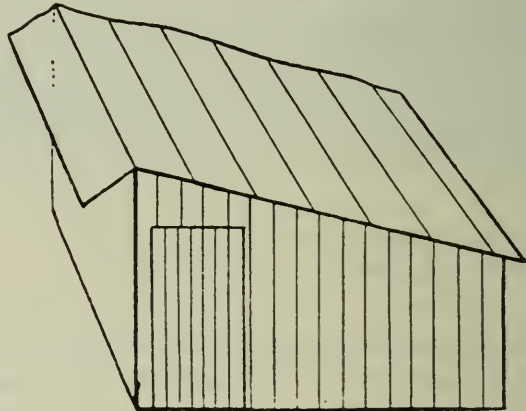
Gable Roof



Shed Roof



1/2 - 2/3 Roof



Shed Roof with Hood

Fig. 50. Roof Types.

It is often possible to remodel old buildings much more cheaply than to build new ones, and still provide efficient accommodation.

(2) **Light:** Sunshine is the best germicidal agent in existence. It is therefore advisable to make provision for the admission of as much direct sunshine into the pen as possible. This is especially important during the Winter and openings should be so placed in the front of the house that they will admit a maximum of sunshine without interfering with ventilation. The value of direct sunshine in the hen house is now becoming more and more appreciated, both from the standpoint of its effect upon the general health of the birds and because of its effect upon the hatchability of the eggs. This action of direct sunshine is due mainly to the ultra violet rays. These are largely filtered out as the sunshine passes through ordinary window glass.

(3) **Dryness:** There are three sources of dampness in the poultry house. A large amount of moisture is exhaled from the lungs of the birds. Moisture sometimes enters the house through a badly constructed floor. Considerable water is also spilled by the birds while drinking. It matters not from what source the moisture comes, if allowed to accumulate in the pen it will gradually lower the vitality of the stock, decreasing production and possibly causing disease. The trouble is usually more marked in the Fall and Winter than during other seasons of the year. Where moisture is not entering the house through the floor or from drip about the drinking dishes, the trouble will be found associated with lack of ventilation.

(4) **Draughts:** There is perhaps no condition in the poultry house that is responsible for more trouble and mortality than draughts. This is particularly true if the birds are in a draught while on the roost. Draughts chill the birds, making them uncomfortable and therefore unproductive. They are also a contributing factor in the production of such diseases as colds, roup, rheumatism and kindred ailments in the flock, which may result in heavy mortality. In constructing the house every effort should be made to eliminate draughts. The sides and back of the house should be absolutely tight, then with ventilation from an open front, or curtains, little difficulty will be experienced.

(5) **Ventilation:** A constant movement of air is essential to health. This can only be secured through an adequate system of ventilation. In a poultry house there is also a humidity problem to contend with, due to the moisture exhaled by the birds, or from other sources. This must be taken care of largely through ventilation. Constant trouble from damp litter and occurrence of frost on the inside of the pens in Winter are definite evidences of insufficient air change. An efficient ventilating system will get rid of this excess moisture and remove foul odours and do so without producing draughts in the house.



Fig. 51. Close-up, showing the ventilating slot-like opening above the windows. A hinged shutter to close ventilating slot appears on the openings on the lower floor.

Various system of ventilation have been tried out from time to time. These have, for the most part, made use of adjustable, cotton-covered frames, glass windows, shutters or open front houses. It has been found in most cases that to attain any degree of efficiency, adjustment of these fixtures from time to time is essential, especially with the changes of weather in the Fall and Winter seasons. Recent observations would suggest that insulation of at least the outside back and end walls and the ceiling are necessary in the development of efficient ventilation. This helps retain some of the heat in the pen and by increasing the contrast between the inside and outside temperatures permits more definite control over air circulation. Insulation of the walls and ceiling also insures lower Summer temperatures in the houses.

Recently Professor W. C. Sanctuary of Massachusetts introduced a new, but comparatively simple, inexpensive and reasonably efficient idea in ventilation. This consists of a narrow slot-like opening along the front of the pen above the windows and curtains. (See Figs. 51, 52 and 53). An opening of two and one-half to three inches deep and the length of the pen appears to be giving best results in Ontario. This may be fitted with shutter or slide for closing in severe weather.



Fig. 52. Inside pen view, showing a slide type of shutter on the inside of the pen for regulating the size of the ventilating opening. The slide at the left is partly closed. The bottom six light sashes have been removed and the three light top lowered for Summer.—(Courtesy M. Fisher).

However, in most cases this slot is left open all the time but adjustments of the slide or shutter will depend to some extent upon the degree of exposure to strong winds.

In milder weather the windows may be opened at the top. The centre windows at least should be made to drop vertically and it would perhaps be better if all windows or curtains were similarly arranged. This is a much more satisfactory arrangement than tipping the windows inwards at the top. The arrangement and adjustment of windows is shown in Figs. 49 and 51.

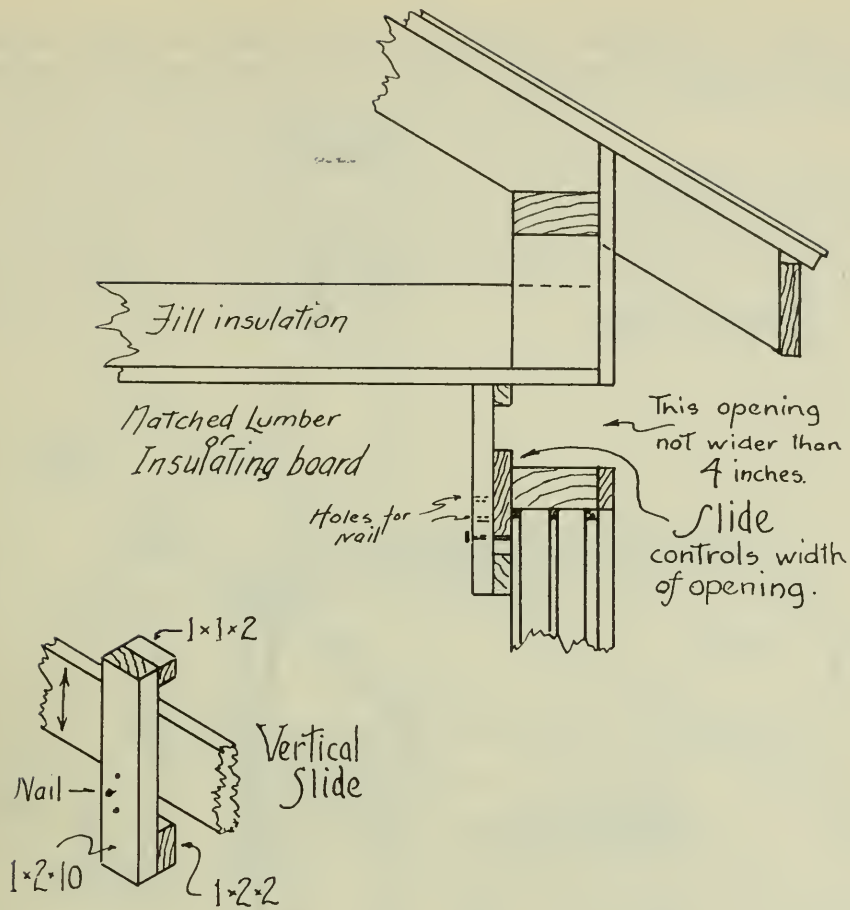


Fig. 53. Showing a detail drawing of a cross-section of ventilation slot above the window with slide shutter on the inside, as suggested in Fig. 52.



Fig. 54. Inside pen view, showing straw loft and ventilating slot through loft next to the front pen wall.—(Courtesy W. L. Whyte).

Another type of ventilator arrangement which may be used, especially where installing pens in a barn, is shown in Figs. 54 and 55. Often the heavy timber of

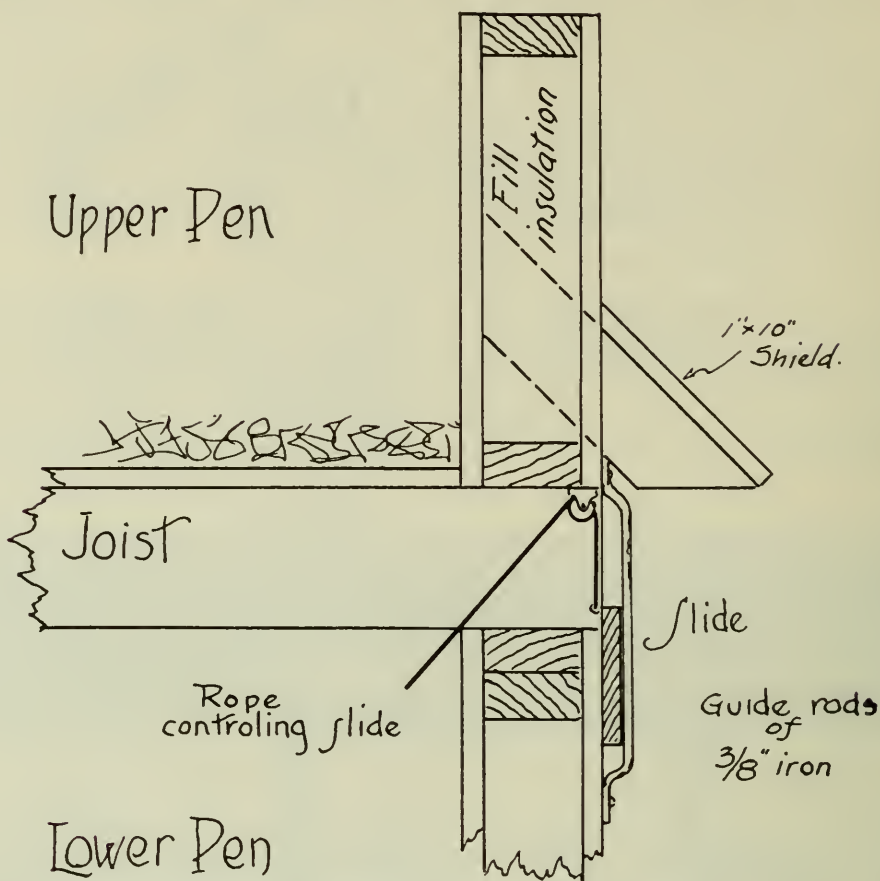


Fig. 55. Drawing detail of ventilator outlet through loft, as shown in Fig. 54.

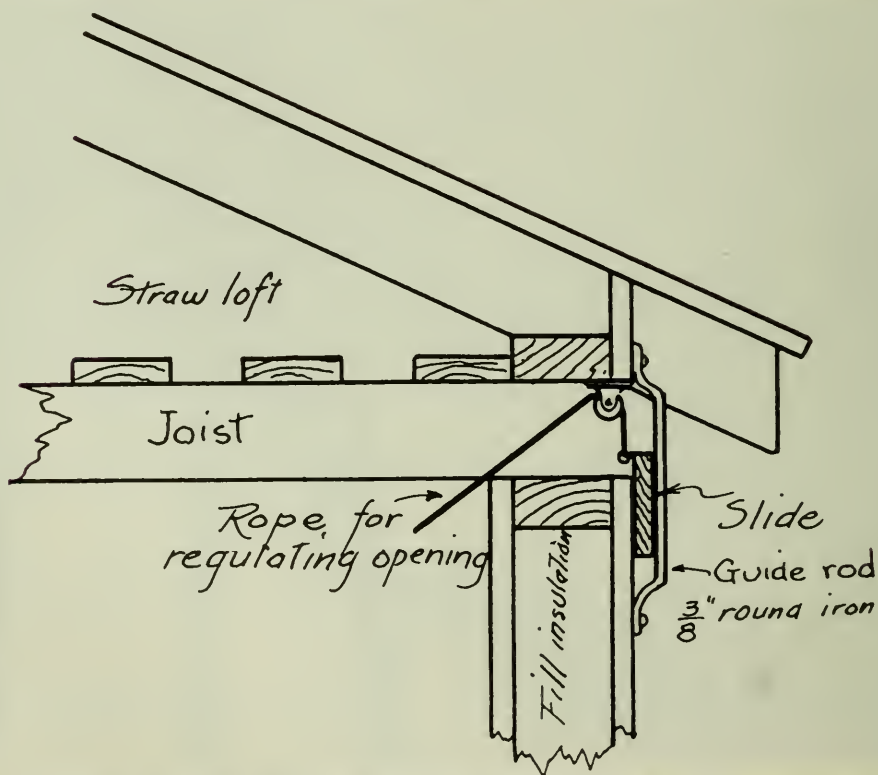


Fig. 56. Detail of ventilator opening and shutter where the ceiling joists run from front to back of pen and joists are not sealed on the under side, as in the bottom storey of a two storey house.

the barn frame and mow sleepers make it impossible to provide an outlet slot through the front at the pen ceiling level. In such a case the ventilating slot through the front edge of the loft or ceiling will prove satisfactory.

In any case where the ceiling joints run from front to back of the pen the front ventilating slot should be between the joists, as shown in Figs. 56 and 57.

This would be the condition in the lower storeys of a double or triple deck house. In such cases a shield or over-hang over the ventilation slots of the lower pens, as shown in Fig. 57, would be necessary.

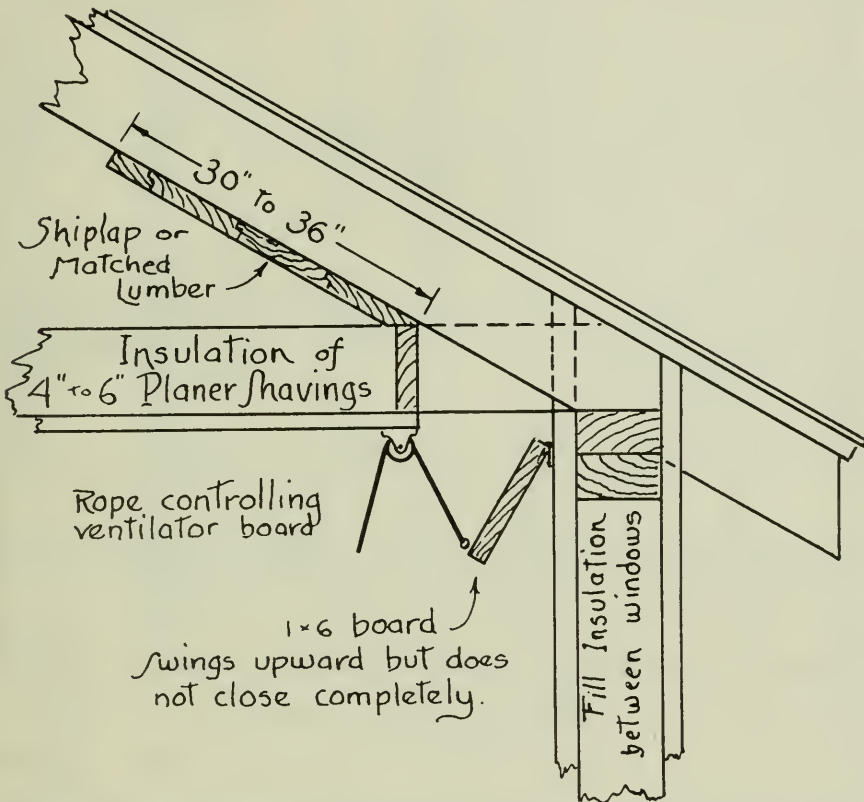


Fig. 57. Construction detail showing ventilation opening and shutter, also the shield over ventilating slot as required in the lower storey of a double deck house.

Shape of Pens: In order that the above system of ventilation may work satisfactorily the pens must be square, or at least the width of the front of the pen should not be greater than the depth of the pen. Pens could, however, be of greater depth than width without interfering with the system's efficiency. In all cases the pens must be separated by tight partitions.

Insulation: The outside walls and ceiling must be insulated, as good results in ventilation cannot be secured without adequate insulation. Dry planer shavings are used extensively for this purpose. To prevent mould forming, as well as exclude mice and rats, construction must be such that no moisture can reach the shavings. Hydrated lime is added to the shavings as they are packed into the wall in the proportion of two pounds of lime to each hundred pounds of shavings, or a quarter pound to each bushel. Dry moss has been used successfully for insulation by some people and the lime might be used here also.

Framing of Multiple Deck House: Multiple deck houses with ventilation between the joists of the lower floors, as illustrated in Fig. 49, need to be well braced on the other three sides. The best method of doing this is by notching the sill and studs on the outside and setting a piece of 1" x 4" lumber in the notches and securing it with three nails in each stud, as shown in Fig. 58. This has been found to increase

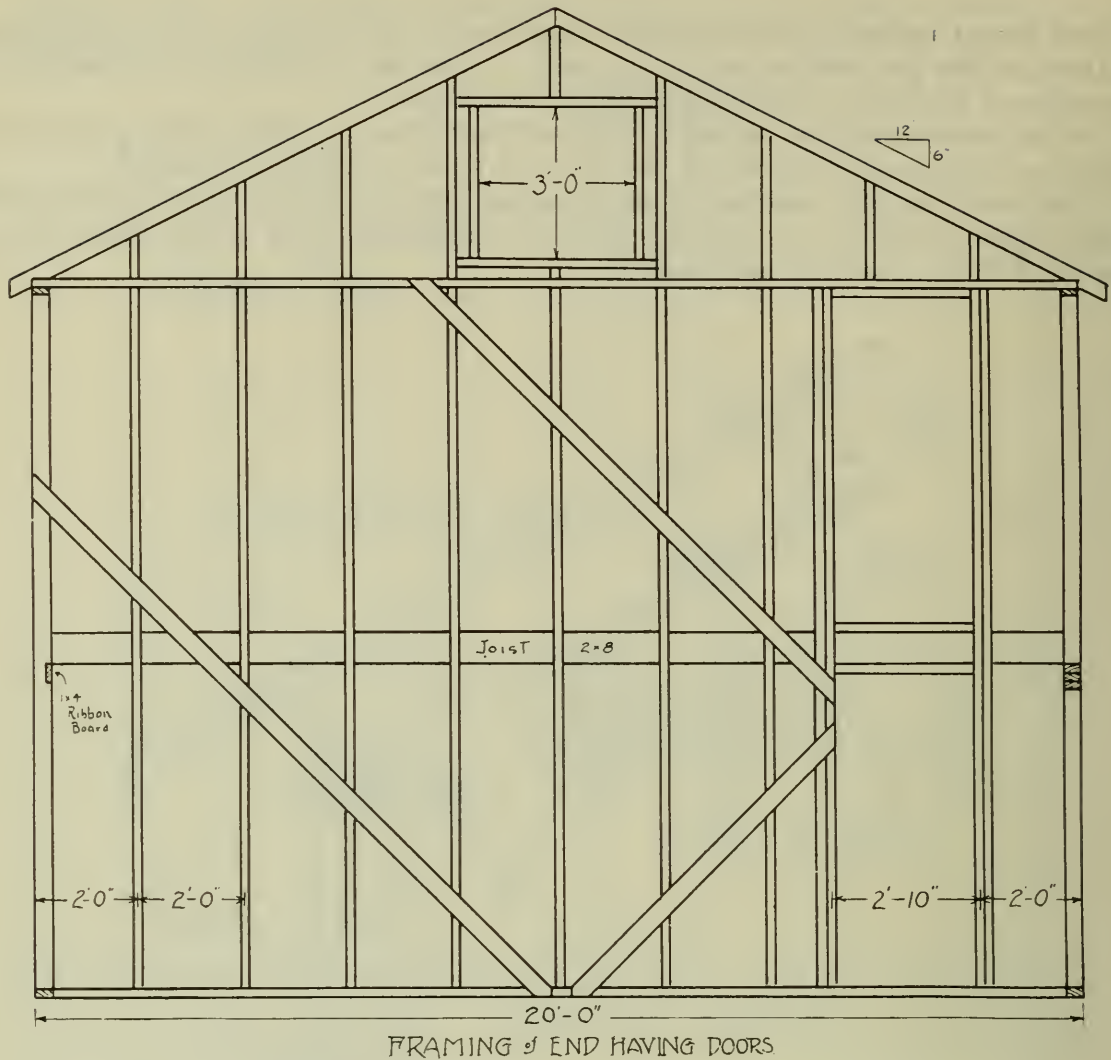


Fig. 58. Framing detail of the end wall of a two storey hen house.

the strength of the wall about four times what it would be if these braces were left out. If the house is to be double-boarded on the outside, putting the inner sheathing on diagonally would also give greater strength at very little increase in cost and makes an exceptionally tight wall. Other framing details are shown in Fig. 59. In Fig. 59 is also shown the framing detail of the front and rear elevation of the house shown in Fig. 49.

Heating Houses: Some poultrymen are heating their poultry houses during the cold weather. This may be done in any one of three or four ways. A brooder stove may be enclosed in a metal box, provided with openings near the bottom for the cold air to come in. Such an arrangement heats the entire house, is comparatively inexpensive, and can be used fairly satisfactorily during extremely cold weather. Other poultrymen use a hot air system with a graduated heating pipe located at the back of the house, below the roosts. In order to secure even heating throughout the house the pipe must be greater in circumference near the heater than at the far end. Hot water heaters with overflow and return pipes located under the roosts and against the back of the house are used in some poultry houses. A satisfactory, controlled system of ventilation is necessary with any method of heating and the house should be insulated to prevent excessive heat loss. It is *important* to use only enough heat to prevent water from freezing. The supplying of a higher temperature than forty-five degrees F. usually results in disastrous moults, with accompanying slumps in egg production.

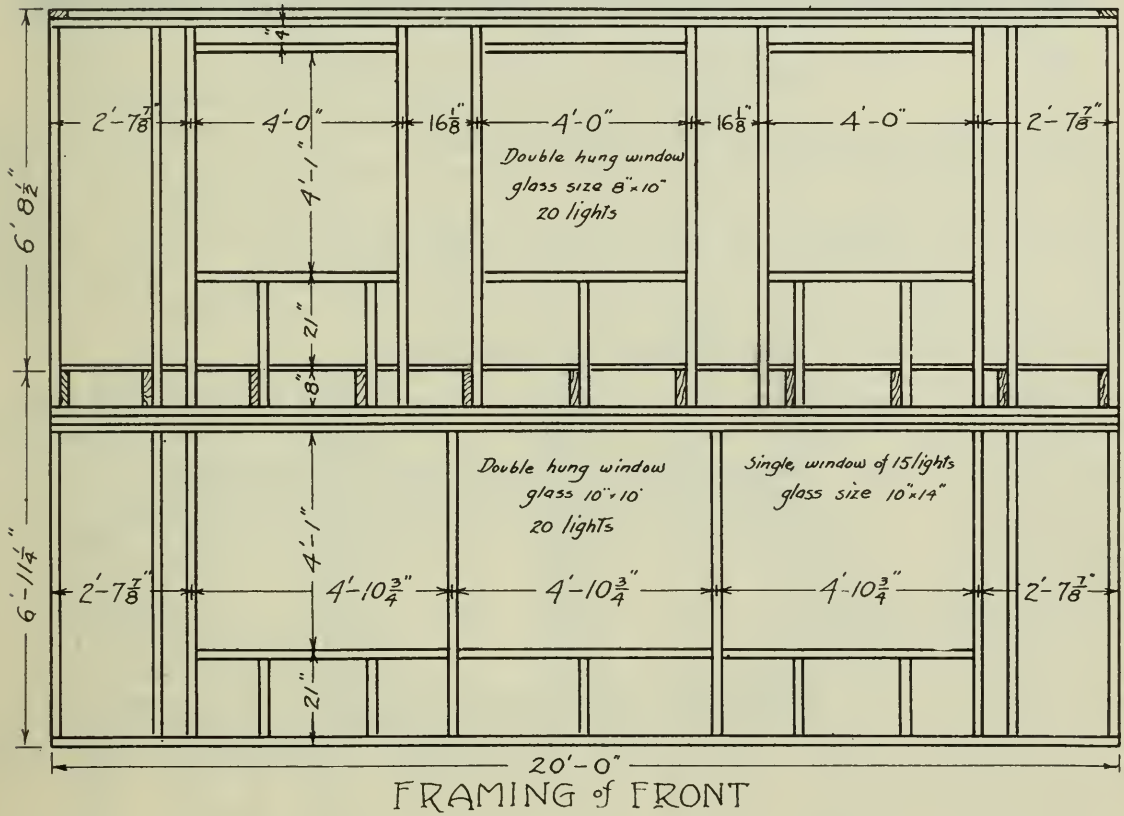
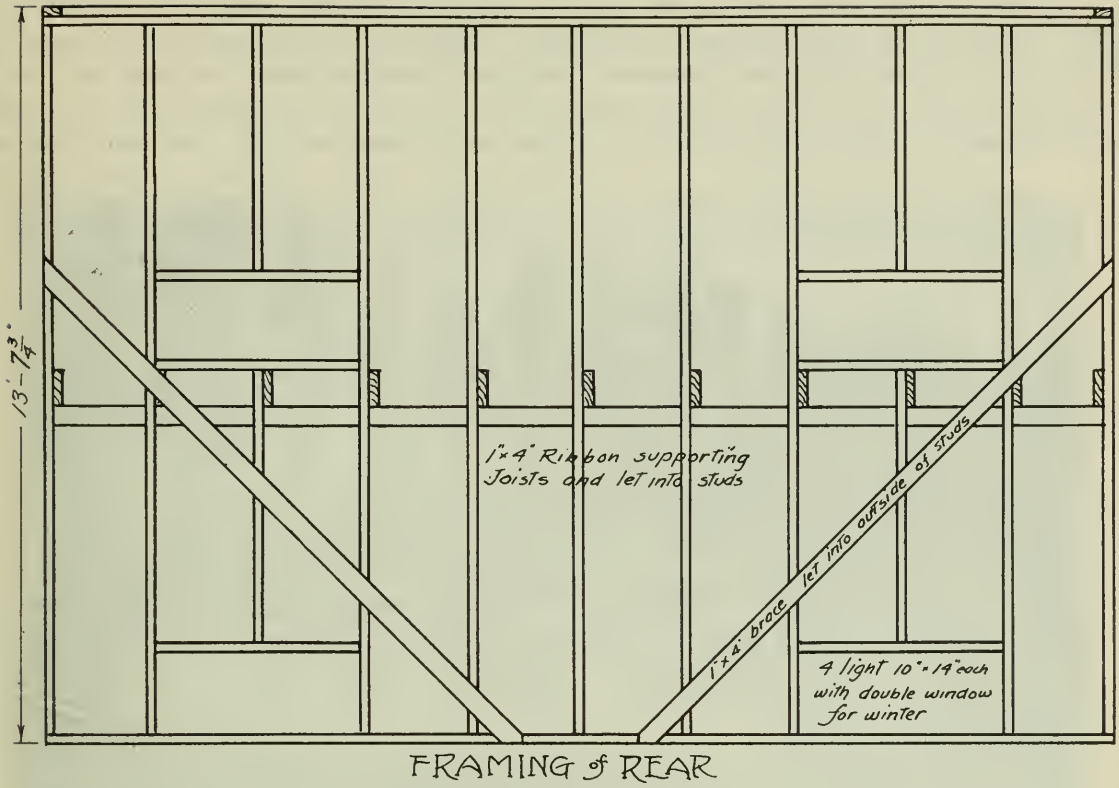


Fig. 59. Framing detail of the front and back walls of the double deck hen house shown in Fig. 49.

It must be borne in mind that the cost of heating frequently offsets the value of the feed saved and any increased egg production secured and it is questionable whether the average poultryman can secure a sufficiently increased return from birds so housed to warrant the cost involved. While it may or may not pay him to heat the house, it will usually be worth while insulating the walls and ceiling to conserve the heat from the birds' body in so far as this is compatible with good ventilation.



Fig. 60. Poultry Breeding house 12' x 60' with glass substitute windows.

Plans and Specifications of College Houses: Because of increased interest in poultry housing throughout the country, we are presenting a type of house which lends itself to a variety of measurements. The plans as submitted show two houses, one twelve feet in depth from front to back, and with twelve foot pens; the other twenty feet in depth from front to back and with twenty foot pens. Either of these houses can be built with any number of pens desired, but maintaining the arrangement and type of construction as shown for the one pen.

The plan of construction of the fronts of these houses is practically identical. The lower section of the front is boarded. Above this is a row of windows extending across the entire front. These are fitted with glass or glass substitutes. In the case of the latter no sash is required as the substitute is attached to a frame, as would be done with cotton. Above the glass windows is a row of cotton curtains. These would possibly be better if placed in guides to slide vertically, as shown in Fig. 63. The plans show doors entering the pens from the front, or a door may be placed at one end of the house, with partition doors in line, which would permit passing from one pen to the next without going out of doors. Two kinds of ceiling construction are used and these are interchangeable. The straw loft has been extensively used in the past and with good results. It assists in the ventilation of the pen and thus reduces trouble from dampness. Some people object to the straw as being dirty and a harbouring place for vermin. Such trouble seldom becomes serious.

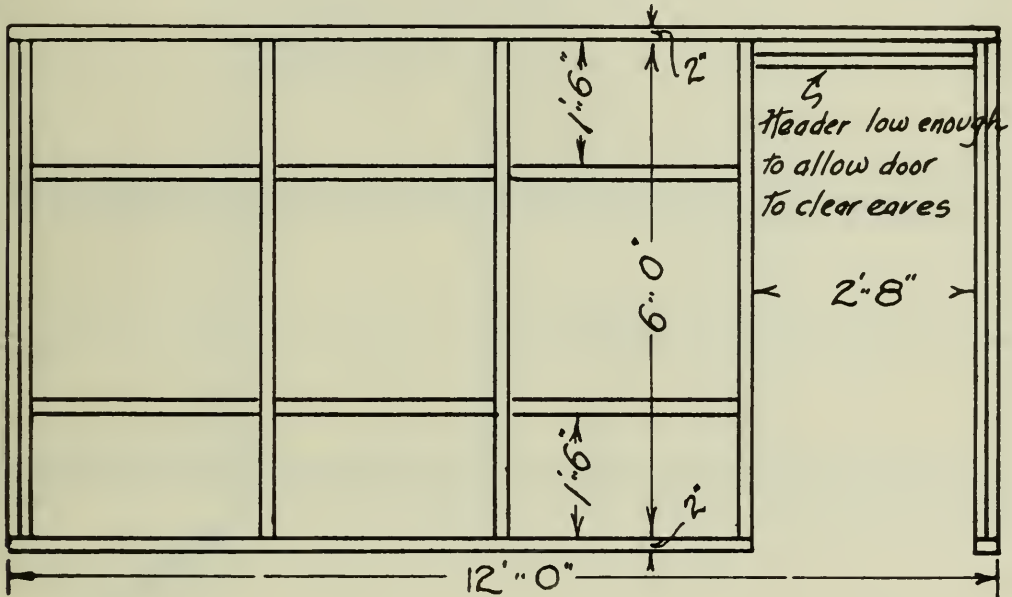
The roofs of both houses are of the gable type. This allows for more effective use of the loft idea.

The capacity of the pens presented is important. While the floor space of the smaller pen is over one-third that of the larger, the housing capacity of the smaller pen is actually one-quarter that of the larger.

The smaller pen will accommodate twenty-five birds, while the 20 x 20 pen will readily accommodate one hundred.

In the operation of these houses, as is the case in any house fitted with adjustable curtains or screens, it requires the constant attention of the operator to secure satisfactory results under all weather conditions. In dull, heavy, humid weather the adjustment of the curtains would be somewhat different from that which would be most satisfactory in bright, clear cold weather, or on rough, stormy days.

FRAMING DETAIL for FRONT.



DETAILED CONSTRUCTION of FRONT.

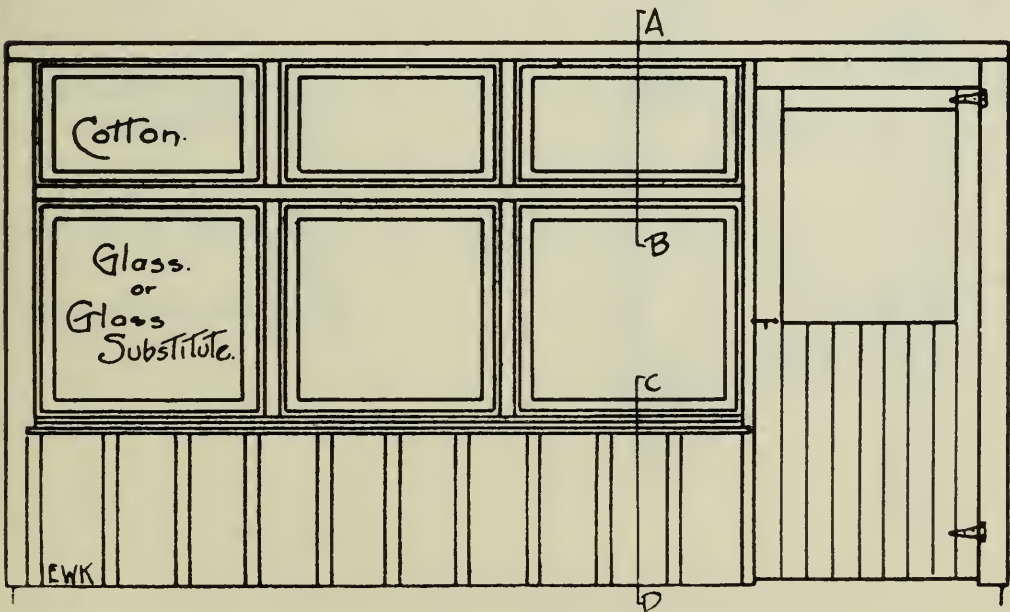


Fig. 61. Plan of house 12' in depth which may be fitted with either straw or cotton loft. It may be built one pen or several pens in length, as desired.

FRAMING DETAIL for ENDS.

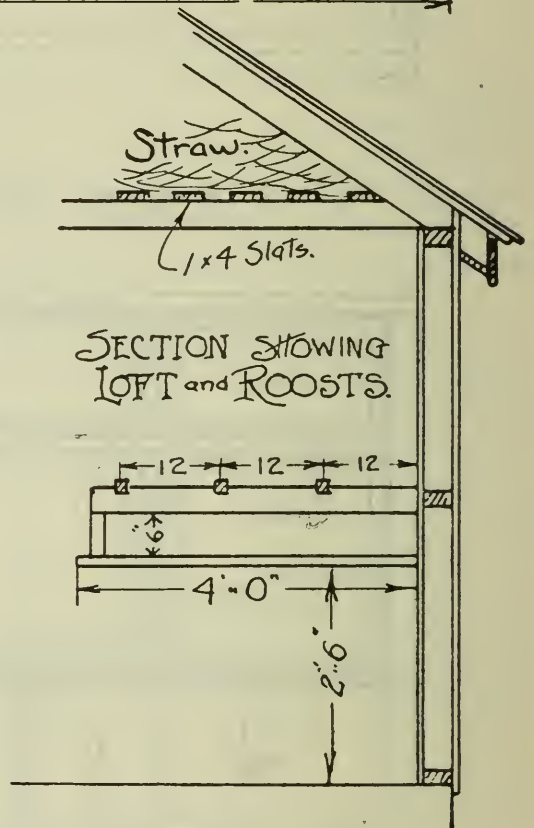
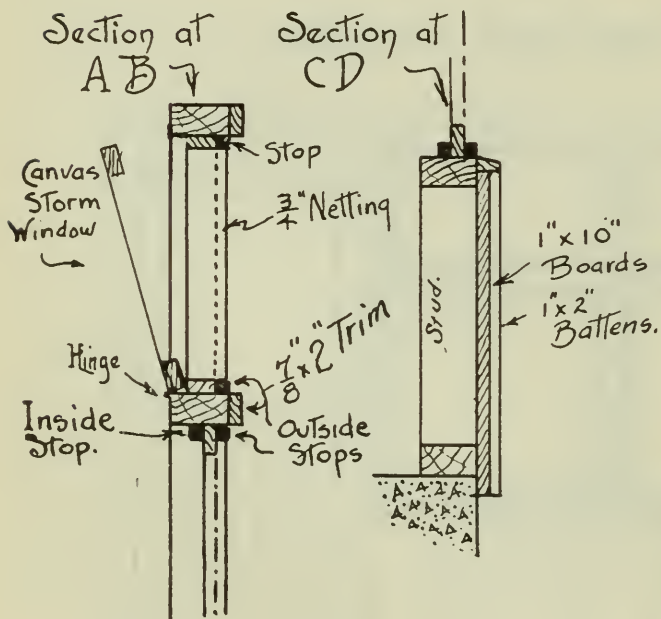
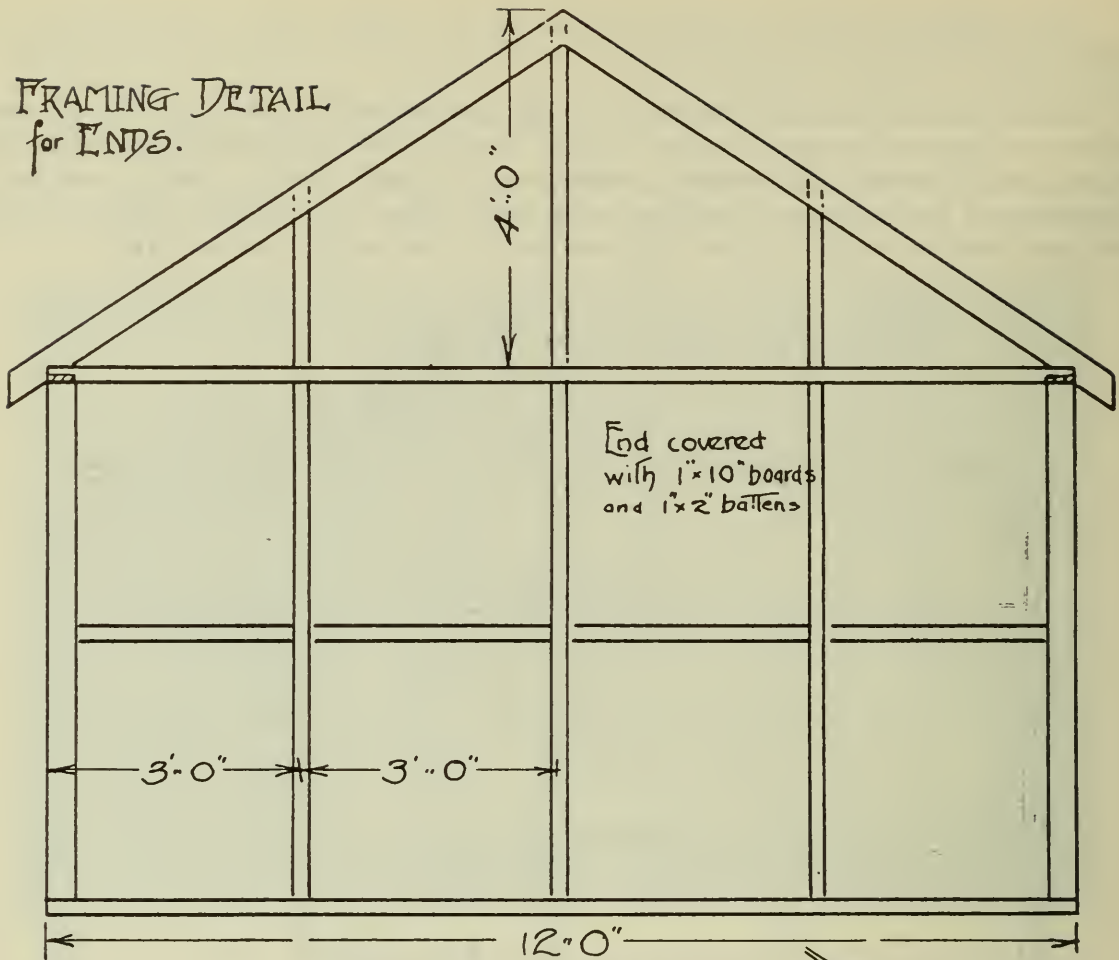


Fig. 62. Framing detail of house shown in Fig. 60.

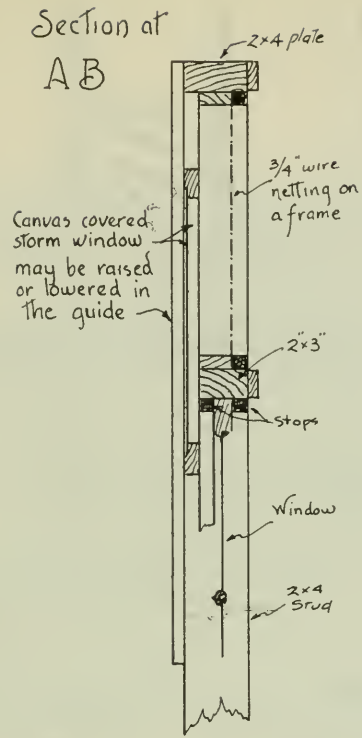
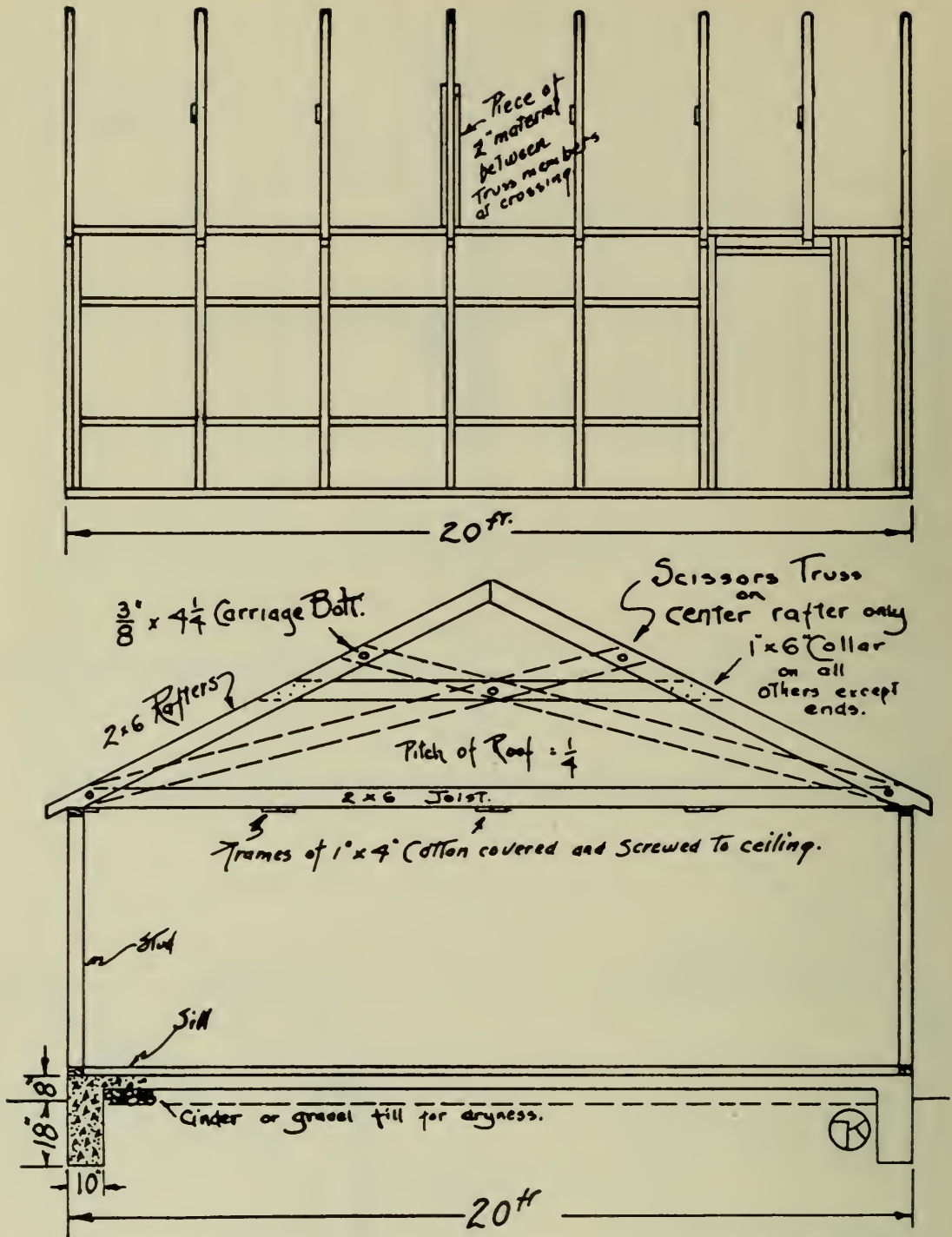


Fig. 63. Detail for slide arrangement of curtains above the windows in Fig. 61 and 62.



Detailed dimensions for this house may be taken from the 12" = 12' one.

Fig. 64.

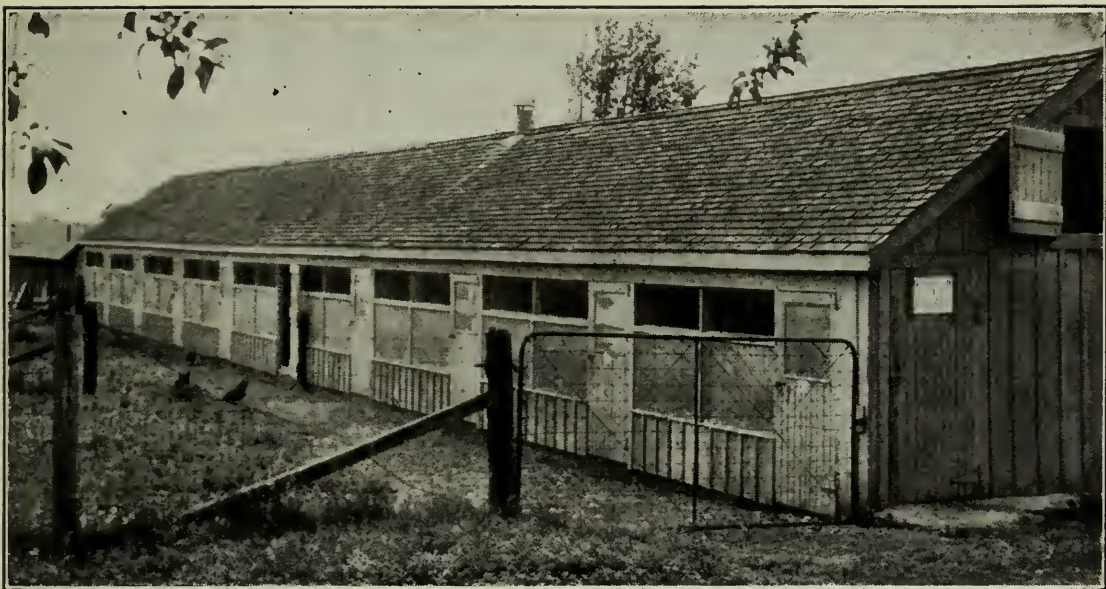


Fig. 65. Laying and Breeding house of the long, continuous type, showing arrangement of cotton curtains above glass windows.

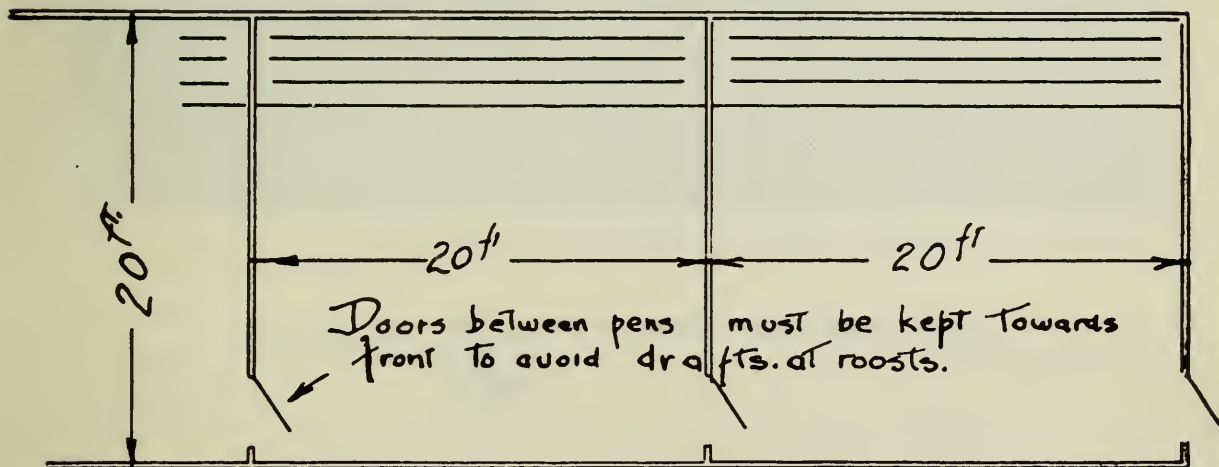


Fig. 66. Showing floor plan arrangement for pens 20' square, and the location of partition doors. This idea may be adopted either in Figs. 49, 60 or 65.

OPEN FRONT HOUSE

The question naturally arises: Can a house be constructed that is nearly self operating, which will keep the birds in health and, at the same time, assure a fair egg production?

Our experience has been that birds thrive best in low roofed buildings, especially so during the Winter. We have two houses with the fronts entirely removed except a two-foot wire netting which keeps the birds in and the sparrows, etc., out. Such houses for this climate must be built low, especially in front, to keep out the snow and wind. It is the opinion of the writers that the house shown in Fig. 67 will meet the needs of the average farmer where he wishes to keep from seventy-five to one hundred hens. While such a building may seem too cold, hens housed in it usually do well, but they could possibly be made to lay more eggs during the months of January and February if the house was constructed with cotton screens properly adjusted to meet the weather conditions. Few farmers, however, would be there at the proper time to do the adjusting, hence we use it entirely open or one-half closed.

The large window in the West, essential for light, should be hinged at the top so that it may be opened during the Summer months, otherwise the house may become too warm.



Fig. 67. Open Front house of the 20' x 20' type.

Bill of Material for Open Front 20' x 20' House

	Number of Pieces	Size	Length
Sill.....	4	4" x 4"	20'
Plates.....	2	4" x 4"	20'
Posts.....			
Back.....	4	4" x 4"	3' 10"
Front.....	4	4" x 4"	2' 8"
Cut and erect the above.			
Ends:			
Rafters.....	4	2" x 6"	12'
Studs.....	2	2" x 4"	16'
Studs.....	2	2" x 4"	12'
Girts.....	2	2" x 4"	12'
Ridge Board.....	1	2" x 6"	20'
Cut and erect the above.			

Siding.....	400 board feet 1" 10" S. 4 S.
Battens.....	250 lineal feet of 1" x 2" S. 4 S.
Put on siding but leave battens until roofing is on.	
Rafters.....	18 2" x 6" 12'
Roof Sheathing.....	560 board feet of 1" x 8" S. 4 S.
or better.....	625 board feet of 1" x 6" Shiplap
Roll Roofing.....	5 rolls, 3 ply best. Do not put on until after trim.
Trim:	
Ends.....	4 1" x 6" 12'
	4 1" x 3 1/2" 12'
	4 1" x 2" 12'
Front.....	1 1" x 10" 14'
	1 1" x 10" 8'
	1 1" x 6" 12'
	1 1" x 6" 8'
	2 1" x 6" 12'
	2 1" x 6" 10'
Back.....	1 1" x 6" 12'
	1 1" x 6" 8'
	2 1" x 6" 12'
	2 1" x 6" 10'
Chicken netting.....	3/4" mesh for front, 3' x 20' piece.
Door.....	25 board feet of 3 1/2" Pine V joint.

It will be noticed that no dropping boards are used in this building. During the Winter the droppings freeze almost as soon as voided, hence produce no odour or bad results, and if the house is cleaned every month it will answer very well. We would rather have this condition than dropping-boards covered a foot deep with droppings, as is frequently seen.

A number of houses of this style are in operation in various parts of the Province and are giving fair results. In some of the colder sections, such as in the district North of Barrie, the house appears to be too open for severe Winter weather. In such cases we would suggest using movable cotton screens on two sections of the front. The illustration shows three sections, one of which would be open except in extreme conditions of cold or wind.

In some cases Open Front houses have been built twelve or fifteen feet deep and twenty or more feet across the front. This is not advisable. If there is a direct wind on the front of the house the birds cannot get far enough back to be out of possible draught. When a smaller house than one twenty feet square is desired it may, for example, be built twenty feet deep and ten feet wide, rather than ten feet deep and twenty feet wide. The width across the front should never exceed the depth in this type of house.

Snow will occasionally blow into the house but we have had very little trouble in this respect. Having the building deep, low and narrow tends to prevent this. A rather small opening in front will not allow the wind and snow to blow far back into the house and the depth allows the birds to keep out of the wind. If there is continuous rainy or damp weather for several days the litter will become damp and should be removed at once. Both walls and floor must be kept dry or the birds are likely to suffer from disease of some kind. There should be no openings except those in the front, otherwise there is likely to be a draught through the house, and this should be avoided.

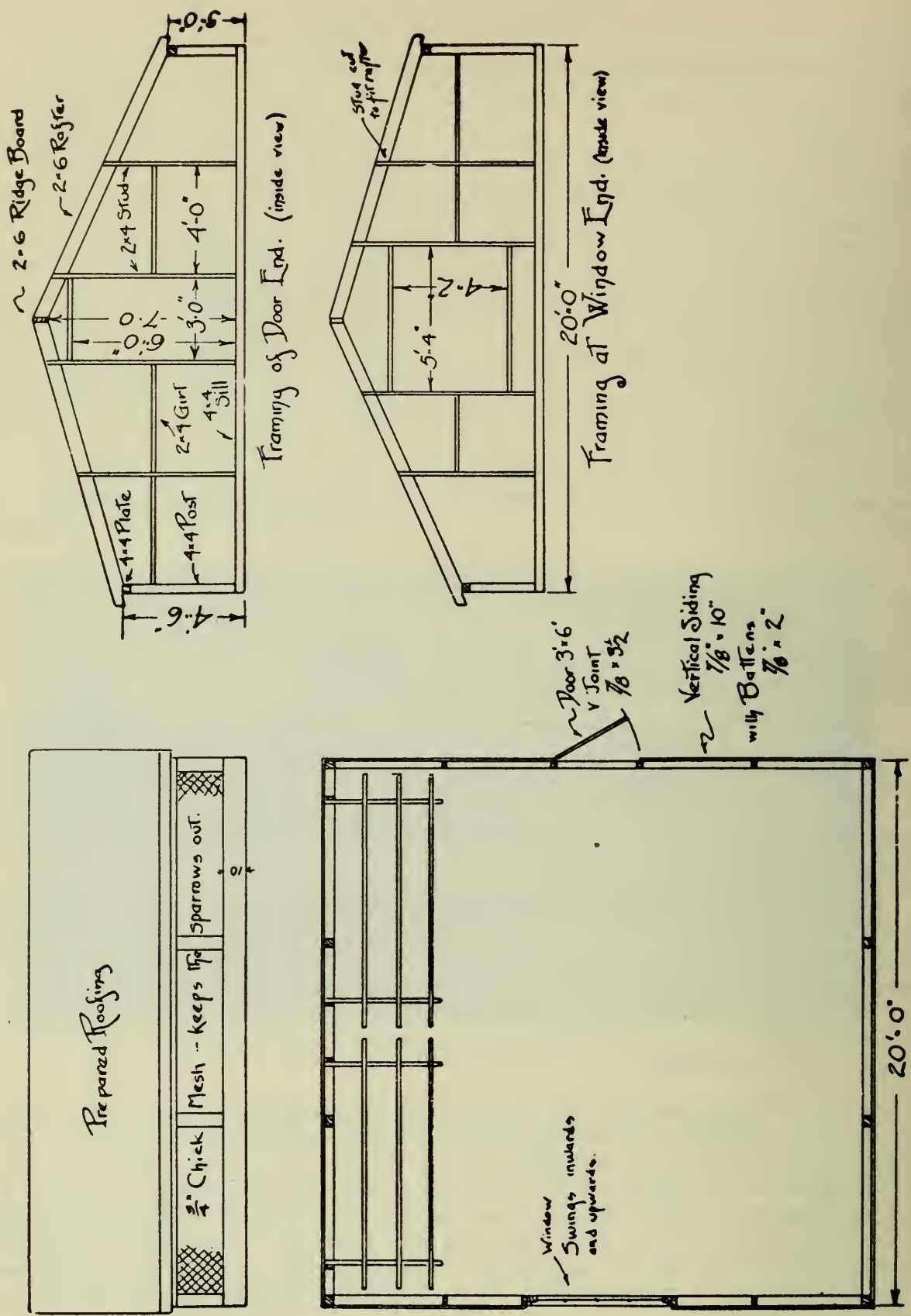


Fig. 68. Plan, elevation and framing sections of a twenty-foot square Open Front House, suitable for the accommodation of one hundred hens.

GENERAL RULES FOR BUILDING

Walls: The size of material used for studding will vary with the type of building. In a single storey house 2" x 4" studding is sufficient. For a two or more deck house it would possibly be better to use 2" x 6" material. Studs are usually set at two to three foot centres. The outside covering is usually one ply matched sheathing, covered with building paper and this covered with such siding material as desired. The inside of the studs and the ceiling may be covered with matched sheathing. Insulation or plaster board may be used on the inside but where used must be protected near the floor, nests and roosts, or where the birds can reach it, as they will destroy the material by picking it to pieces. When the inside sheathing is being put on, the wall space should be packed with dry planer shavings or other insulating material. The ceiling should also be covered to a depth of four inches with planer shavings or eight inches of straw for insulation.

Roosting requirements differ with the different breeds. Brahmas, Cochins, and other heavy breeds, require ten inches of perch room per bird; Plymouth Rocks, Wyandottes, Rhode Island Reds, etc., require about nine inches; Leghorns, etc., about eight inches. All perches should be placed on the level, as in Fig. 62. Perches built ladder style result in the birds crowding on the top perch, thereby causing trouble. Roosts should be built low or near the floor. There are several reasons for this: birds of the heavy breeds cannot fly high up and are liable to injure the soles of their feet in jumping down from high perches. Roosts two inches square, or two inches by three inches, are preferred, the upper edges to be slightly rounded.

WALL NESTS.

Material for 3 Section Nest.

Top.	2 pcs	$\frac{3}{4}$ "	x	12"	x	50"		
Bottom.	2 pcs	"	x	6"	x	48"		
	1 pc.	"	x	8"	x	64"	14½	10½
Front.	2 pcs	"	x	6"	x	48"		
Back.	1 pc.	"	x	8"	x	48"	10½	14½
Ends.	1 pc.	"	x	8"	x	24¾"	CUT	
	1 pc.	"	x	11½"	x	30½"		12
Partitions	1 pc.	"	x	11½"	x	30½"	18½	
Strips 'A'.	2 pcs.	$\frac{1}{2}$ "	x	3"	x	48"	12	10½
Stop Block B	2 pcs.	$\frac{3}{4}$ "	x	3"	x	9"		

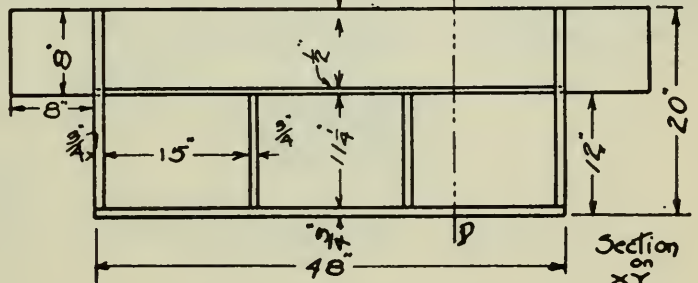
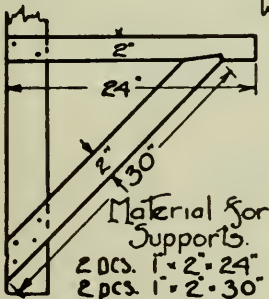
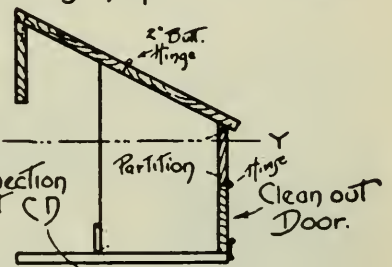
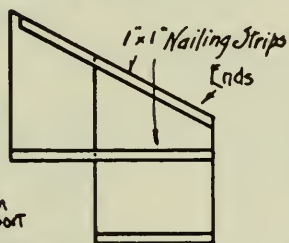
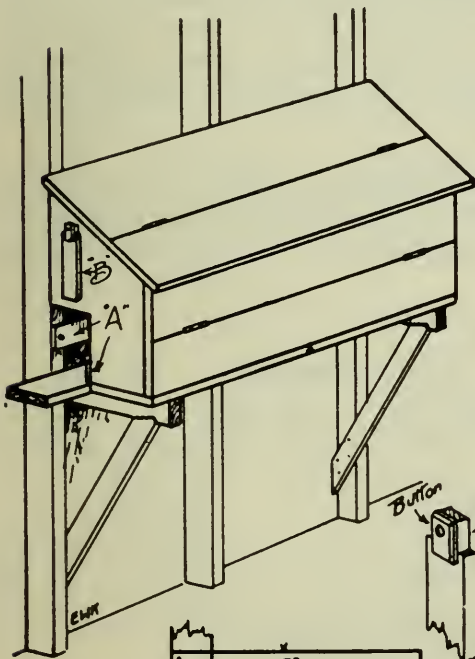


Fig. 69. A convenient type of open nest which may be supported upon brackets on the wall, allowing free use of floor space for the hens.

Dropping Boards: When dropping boards are used they should be moderately low down to admit of easy cleaning. These should be made of matched lumber and should be twenty inches wide for one roost and three feet wide for two, the first perch being placed ten inches from the wall and the others at fourteen inch centres. If dropping boards are set free of the back wall two or three inches it will permit better air circulation and more thorough ventilation.

Nests: These should be provided at the rate of one to every four or five hens in the pen. All types and sizes of nests are used but with open nests more trouble may be experienced from hens eating their eggs. This is overcome by providing nests which are partially darkened, as in the case of Fig. 69. The semi-darkened nest may also assist in preventing vent picking and cannibalism. Raising the nests off the floor permits the use of the entire floor space for scratching purposes. All nests should be from twelve to fourteen inches square and not over six inches deep.

Trap nests are necessary where pedigree breeding is to be conducted. Whether or not it is advisable for a man to trap-nest his stock will depend on his object, the time available, and the expense he is willing to incur in attaining the same. The price of trap nests varies from eighty cents to one dollar and eighty cents each. The cost of operating these is approximately one dollar per bird per year, which will not include the keeping of progeny test records. Where trap nests are used they must be visited at one and one-half to two hour intervals during the day. This is especially important during hot Summer weather as otherwise the birds are liable to die on the nests from suffocation.

Trap nests are, for the most part, patented. The nest which we have used for a number of years, and which we believe is as efficient as any on the market, is the one shown in Fig. 70. This nest represents in a general way the type of most trap nests. It is made up of two compartments, with a trap or door on the front end which closes automatically when the bird enters the nest, thus keeping it captive until released by the attendant.

The nest is constructed of seven-sixteenth inch material, twenty inches long, thirteen inches wide and thirteen and one-half inches high. The front of the nest is left open at the bottom, which greatly facilitates the removal of the hen after laying.

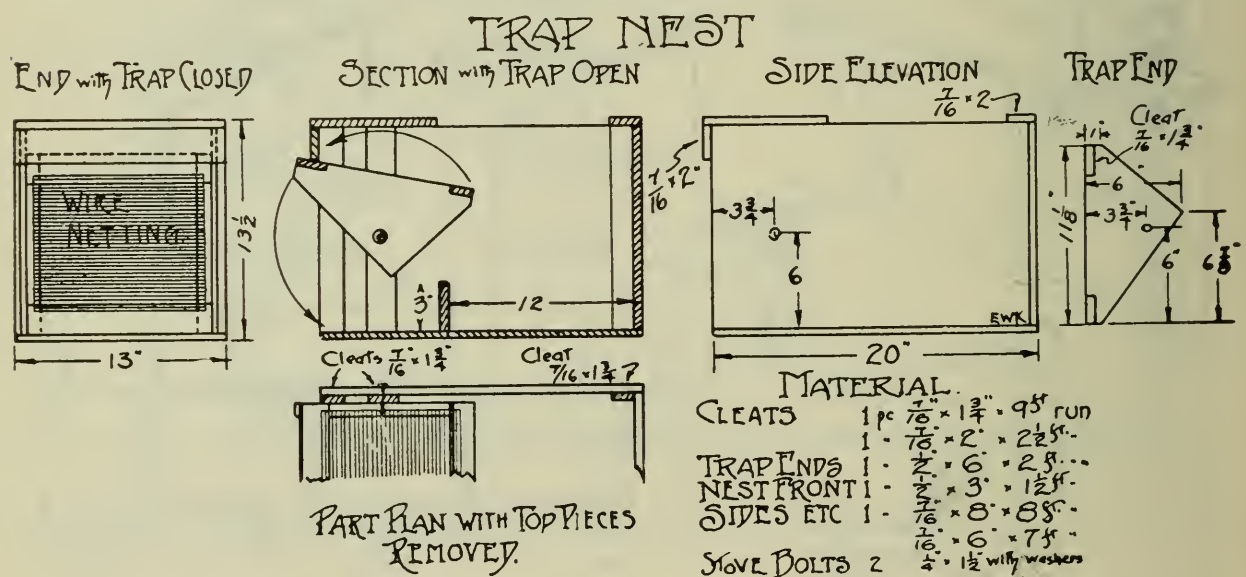


Fig. 70. Plans and specifications for the trap nest in which the type of construction of trap and its adjustment allows for the entire lower section of the front to open. This greatly facilitates removing the hens from the nest.

A three inch board is placed across the bottom of the nest and divides it into two compartments. The trap has a straight wire front and is so adjusted in the nest that as the bird steps over the three inch partition her back comes in contact with the trap and it tips forward, thereby closing the trap.

Drinking utensils of some form or other are necessary and the more simple they are in construction, the better. The writers have found open pans as efficient as any, the size of the pan depending on the size of the flock to be accommodated. They should be made of some material which is smooth and as free from seams as possible, to facilitate cleaning, because frequent cleaning of drinking utensils is necessary to prevent them from becoming slimy and unsanitary. In large flocks we have used steel hog troughs, holding from twenty to thirty quarts, with good results.

In our experience the largest egg yields are obtained from flocks containing from twenty to thirty birds. Some succeed with two hundred or more in a flock. Considering, however, the cost of housing, labour, etc., the most economical returns will probably be secured from flocks of about one hundred birds.

COLONY HOUSES

There is a constant demand from people living in towns and cities for plans of houses suitable for housing six to twelve hens. In some instances they wish these houses so constructed that they can be moved easily from place to place.

The man who is using artificial means of brooding, and raises over one hundred chicks, is finding the portable colony house a valuable addition to his equipment, as it enables him to place his young chicks on fresh ground every year.

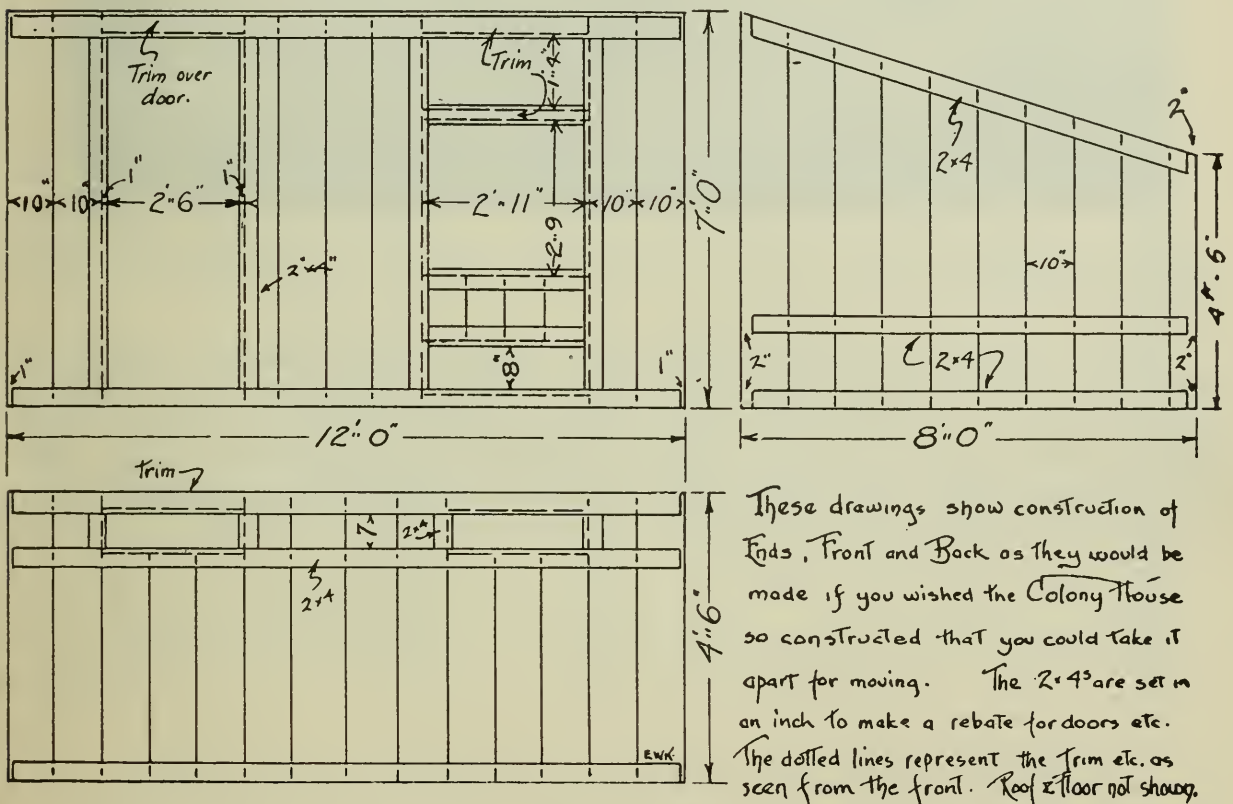


Fig. 71. Plans showing front, end and rear wall construction where desired to have the house of the take-down type.

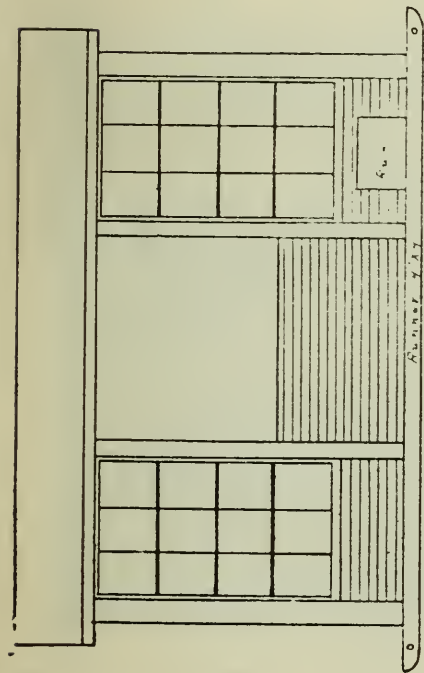
Bill of Material for 8' x 12' Colony House

3 pcs.	4" x 4" x 14'	Hemlock, Cedar or Pine	Runners
2 "	2" x 4" x 12'	Hemlock or Spruce	Runners
2 "	2" x 4" x 14'	Hemlock or Spruce	End Sills—Girts
7 "	2" x 4" x 16'	Hemlock or Spruce	Rafters
3 "	2" x 4" x 12'	Hemlock or Spruce	Plates, back girt
6 "	2" x 3" x 14'	Hemlock or Spruce	Corners, door and window sides
3 "	2" x 3" x 12'	Spruce	Roosts
100 board feet,	face $\frac{7}{8}$ "	Spruce flooring	
	(16' long)		Floor
210 board feet,	1" x 10"		Outside Sheeting
250 lineal feet,	$\frac{1}{2}$ " x 2"		Battens
110 board feet,	roof boards	Hemlock	
1 square	shingle		
3 pieces	1" x 4" x 14'		Door and cornice
2 pieces	1" x 3" x 10'		For cornice ends
1 sash,	1 $\frac{3}{8}$ " thick;	6 lights, 10" x 14"	glass.

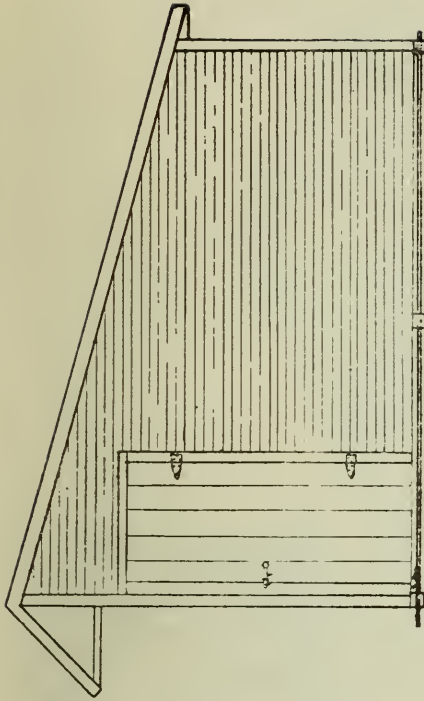


Fig. 72. Colony house 12' x 12', suitable for large size brooding pen or small mating of breeders.

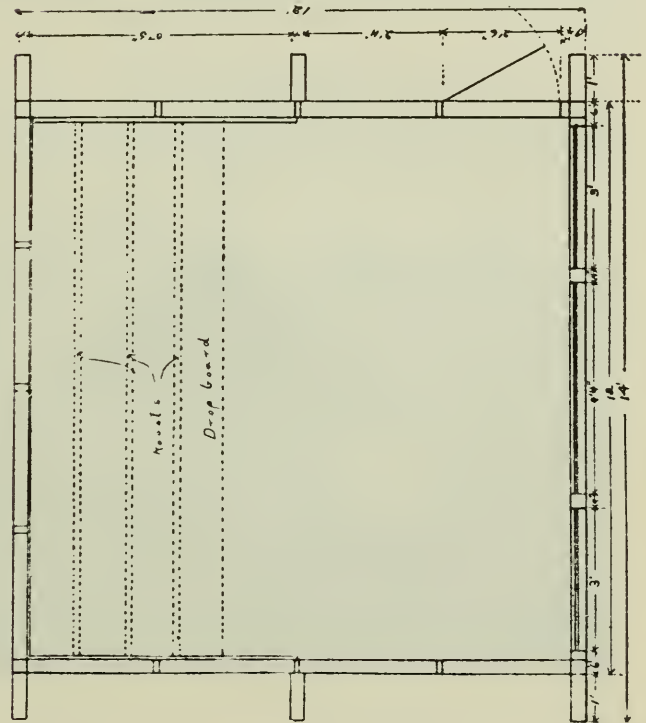
In Figs. 72 and 73 are shown a large type of colony house which is suitable for operating a colony coal-burning brooder stove, rearing chicks on range, or for a small breeding pen. The house is twelve feet by twelve feet, built on runners and, while portable, cannot be moved as easily or satisfactorily as the smaller house. This house has been tested out by the writers, both for brooding and for wintering laying hens, and has proven quite satisfactory.



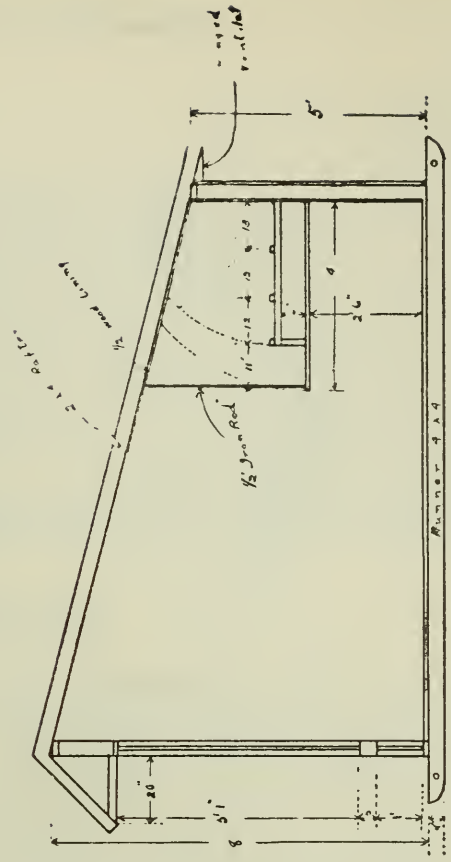
Front Elevation



End Elevation



Floor Plan



Cross Section

Fig. 73. Plans, elevation and cross-section of 12' x 12' Colony house.

Bill of Material for 12' x 12' House

3 pieces, 4" x 4" x 14'	Runners
11 pieces, 2" x 4" x 12'	Hemlock Joist Plates
16 pieces, 2" x 4" x 14'	Hemlock Rafters, Studs, etc.
3 pieces, 2" x 2" x 12'	Roosts
200 feet Matched Hemlock Roof Boards	
230 feet 1" Spruce Flooring, 12' long, Floor and drop board	
300 feet 1" Novelty Siding, 12' long, outside walls	
8 pieces 1" x 3" x 14', for window casings and cornice	
10 pieces 1" x 2" x 14' for screens (cotton for winter)	
3 yards 30" wire for screens (wire for summer)	
4 yards 36" wire for windows	
100 feet ½" matched Spruce sheathing inside, above drop board	
2 Sash, 12 lights, 10" x 14", 1 ¾" thick	
2 Square Paroid Roofing	
1 Door, 2' 7" x 5' 11" and join	
Dropping board is 3' 8" wide x 12' long	
3 Roosts 10" above drop board, 8' long, about 12" apart.	

RANGE SHELTERS

The use of the range shelter is becoming quite general. While not adaptable for early Spring use, it is just as efficient and much less expensive than a Colony House as a shelter under Summer conditions. It may be easily constructed by practically anyone. The structure is light and can therefore be easily moved about the range. The usual practice is to place a shelter beside a colony house of chickens, and as they grow and the house becomes crowded, and when heat is not essential, the chickens overflow to the shelters. In late June or early July chickens not requiring heat may be transferred directly to the shelters. Where the surroundings become badly soiled with droppings or mud, the shelter should be moved to a new location.



Fig. 74. Range Shelter for range rearing after chicks are feathered and are safe to leave without artificial heat.

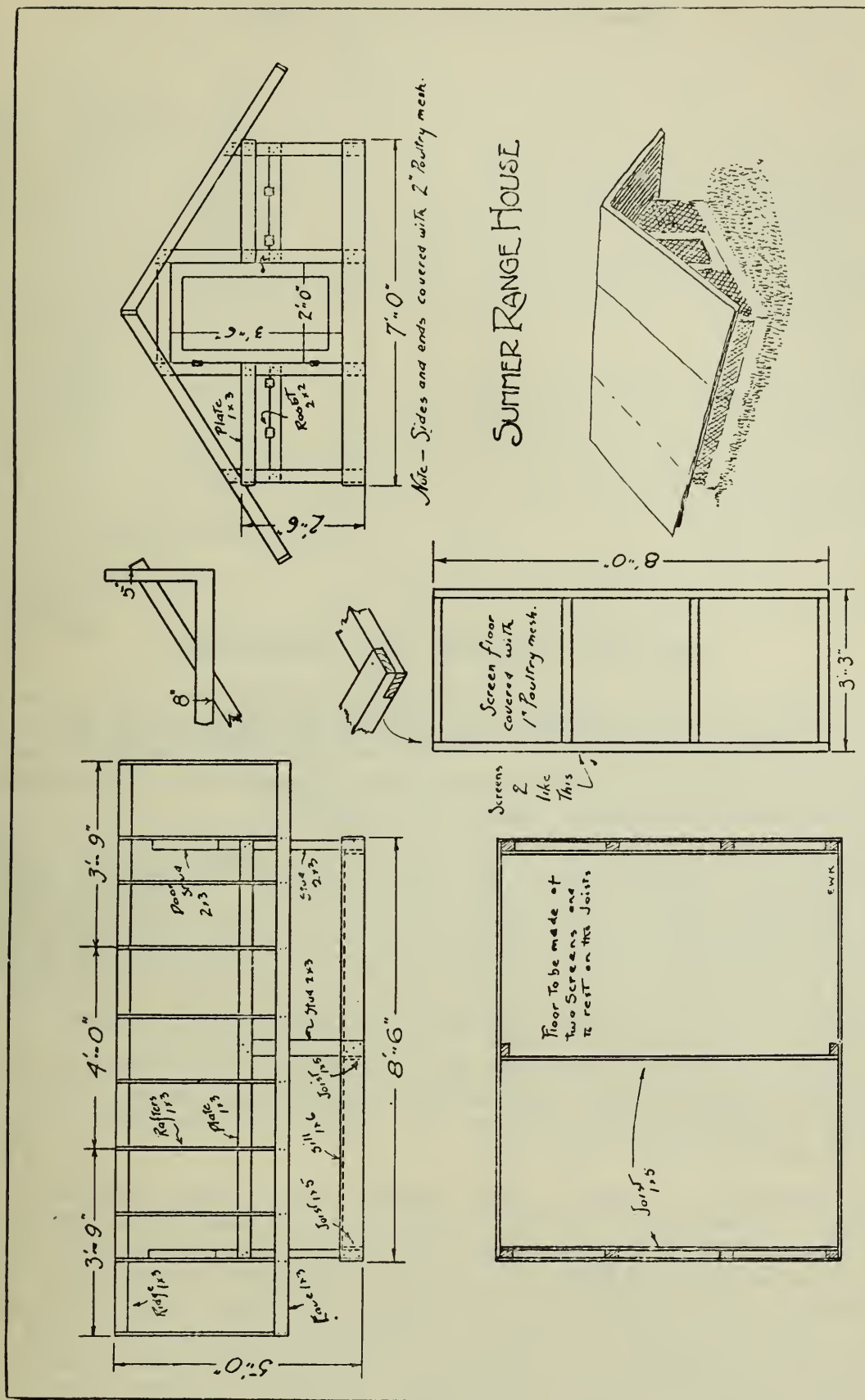


Fig. 75. Plans and construction detail for Range Shelter shown in Fig. 74.

Bill of Material for Range Shelter

Parts	Number of Pieces	Size	Length
Roof.....	12	3' x 4'	Masonite Prestwood
Rafters.....	20	1" x 3"	6'
Ridges and Eaves.....	3	1" x 3"	11' 5"
Plates—Side.....	2	1" x 3"	8' 4 ½"
Back.....	1	1" x 3"	7'
Front.....	2	1" x 3"	2' 6"
Sills—Side.....	2	1" x 6"	8' 4 ½"
End.....	2	1" x 6"	7'
Studs—Corners.....	4	2" x 3"	2' 8 ½"
Side.....	2	2" x 3"	2' 6"
Door.....	4	2" x 3"	4' 2"
Roosts.....	4	2" x 2"	8' 5"
Roost Brackets.....	4	1" x 3"	2' 5"
Door—Stiles.....	2	1" x 3"	3' 5"
Rails.....	2	1" x 3"	2'
Wire.....	14 yards	24" wide	
Hinges.....	1 pair	3" Butts	
Hook and Eye.....	1 set		
Joist for Floor Screens.....	3, 7/8"	x 4 ¾ x 6' 10 ¼"	

POULTRY HYGIENE AND SANITATION

The present heavy losses among poultry flocks may be prevented. Too many people are thinking of curing diseases and parasitic infestations rather than preventing their introduction into the flock. While there are some conditions which may respond to treatment, the results are usually very disappointing. This is one place where "an ounce of prevention is worth *pounds* of cure."

It is now a well established fact that many of our common diseases of poultry are carried over from one year to the next by so-called "carriers" or birds that recovered from an attack of the disease the previous year. Such birds contacting young growing chickens may readily start an outbreak of the disease in the young birds although showing no outer evidence of the trouble themselves. Resistance to infection increases with age so that the longer the young birds can be kept from contacts with infection or parasitic infestations the less possibility of trouble starting.

Breeding stock should be selected for vigour as well as breed quality. Pedigree or production records, while important, are secondary to vigour in a breeding programme. Birds which have been seriously affected by disease or parasitism are better discarded from the breeding pen.

An abundance of fresh air and sunshine are important in housing birds. Ventilation that will control moisture, without causing draughty conditions in the pen, is necessary. The frequent removal of the droppings and changing of the litter as it becomes soiled, will help keep the houses in a more sanitary condition. At least once during the year, preferably in the Summer, the houses should be thoroughly cleaned and, if water under pressure is not available for washing, the inside of the house should be disinfected. In cleaning, all movable fittings such as nests, roosts and hoppers, should be removed. Thoroughly scrape the dropping boards, if used, remove all litter from the floor, then brush the ceiling and walls with a broom. The floor should be scraped as clean as possible and the inside of the pen then scrubbed with a hot lye solution UNTIL IT IS CLEAN. The house is then ready to be disinfected. If the operator wishes to whitewash the pen, the disinfectant may be satisfactorily mixed in the whitewash solution. The disinfecting solution should be

applied with sufficient pressure to force it into the cracks and crevices of the building. Nests, roosts and other removable fittings may be treated by dipping them in disinfectant solution, or if this is not possible they may be sprayed.

The yards and range must receive some attention. Cultivation, and where possible cropping, will not only help keep the land in a more sanitary condition but will also help supply succulent green feed. Land that is not stirred up occasionally, and especially if it is shaded from the sun, is more likely to retain infectious material. Where cultivation of the land is not possible, rotation of range should be practised and houses and range shelters moved several times during the rearing season. Moving feed hoppers and drinking fountains twice a week will prevent the accumulation of manure on the ground around this equipment and hence the contamination of feed and drink which may be spilled.

A well balanced diet is important. This may mean special attention to supplying the supplementary feed factors, such as minerals and vitamins, especially where home grown feeds are used largely. A properly nourished bird is a more healthy bird.

If bringing in birds from outside sources the greatest care should be taken to avoid bringing in disease. There is always some danger in allowing persons other than the attendant to enter the pens or yards. In no case should live poultry crates used by poultry buyers be taken into the flock quarters.

Birds which become badly infested with vermin should be treated to get rid of the infestation. While such parasites may not actually cause mortality in the flock, they affect the birds' vitality and lower resistance to infections.

WHITEWASHES FOR FARM USE

E. W. Kendall, B.S.A., Department of Farm Mechanics

Whitewash has a wide application to farm use and deserves a much greater popularity than it, at present enjoys. Its ingredients are inexpensive and readily obtained. It is not difficult to make and it is easy to apply. In addition to these advantages, it protects the surface to which it is applied, brightens up dark interiors and improves sanitation. A fact not generally known is that whitewash may be coloured, provided that light tints and shades are used and that the pigments are not affected by lime. Among such are yellow ochre, raw and burnt umber and raw and burnt sienna.

Preparation of the Surface. The surface to be whitewashed should be just as clean as one that is to be painted and it is a first essential to good results that all dirt, grease and scaly material be removed before there is any attempt to apply the wash. This implies a liberal use of scrapers and stiff brushes. When the cleaning is finished and the surface dusted, it is well to dampen it slightly before applying the wash.

Application of Whitewash. Whitewash may be applied with a brush or with a sprayer. In applying with a brush use one at least four inches wide and work rapidly, making no attempt to "brush out," as in painting. Let the coat be fairly thin and transparent. It will be opaque when dry. Small hand sprayers such as sold by Seed Firms may be used. These will cost around \$10.00 and should be of brass if you expect them to last for a number of years. In using sprayers it is quite necessary that the wash be strained through at least two thicknesses of cheese cloth. Spraying under certain conditions has many advantages over brushing, as it forces the material into cracks and crevices that would not be reached by the brush. In using the sprayer always hold the nozzle so that the wash is applied at right angles to the surface; this gives even application. The sprayer should be thoroughly cleaned after use and especially the nozzles, as a small particle of dirt clogging one side of the nozzle will cause it to send out a lop-sided stream, and the work will be patchy.

ACKNOWLEDGEMENTS

The Poultry Department wishes to acknowledge the assistance of the following men in the preparation of the material in this Bulletin:

DR. H. D. BRANION, Nutrition Department, on rations and nutrition.

PROFESSOR E. W. KENDALL, Agricultural Engineering Department, in the preparation of plans and specifications of houses and equipment.

MR. W. D. TOLTON, Extension Department, in securing photographs of houses, pasture scenes and birds for illustrations.

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BULLETIN 396

SEPTEMBER, 1938

Ontario Department of Agriculture
ONTARIO VETERINARY COLLEGE

MASTITIS OR GARGET IN COWS

BY

C. D. McGILVRAY, M.D.V., D.V.Sc.

FOREWORD

This bulletin has been prepared to meet a popular demand and to furnish such information regarding "Mastitis or Garget in Cows" as may seem justified at the present time. In the hope that it may serve a useful purpose it has been deemed desirable in its preparation to avoid the use of technical terms as far as possible. It should, however, be kept in mind that mastitis is essentially a serious infectious udder disease of cows requiring technical skill for its prevention and treatment. As a rule owners will find it both prudent and timely to consult their veterinary surgeon as to the handling of this disease as soon as it appears in their herds. By so doing those concerned will be serving their own interests rather than to attempt temporizing treatment of individual cases which may result in the further spread of the disease in their herd.

"The disease is not one which usually responds to ordinary palliative treatment but is one which requires skillful help and guidance for its control in most cases."

NATURE OF THE DISEASE

Mastitis, which is commonly known as "garget" is essentially a progressive inflammation of the milk secreting tissues of the mammary gland or udder.

High producing cows are to some extent most susceptible, hence the disease is more prevalent and detrimental in good dairy herds. It may occur in various forms influenced to some extent by the age and condition of the cow, high protein feeding, the degree and stage of lactation, the physical condition of the udder and the exact nature of the agent or cause responsible for the attack. For convenience of general description the various forms of mastitis may be divided into acute and chronic cases.

The initial attack may be acute and develop suddenly, but generally speaking the majority of cases incline to the chronic form consisting of a progressive inflammation with occasional acute attacks.

The persistence of the inflammation damages and destroys the milk secreting tissues of the udder, and results sooner or later in fibrous induration (caking or hardening of the udder) with altered and diminished milk secretion.

As a rule the disease is of infectious origin and is therefore frequently spoken of as "*Infectious Mastitis*" or "*Streptococcic Mastitis*". This is owing to the fact that the germs causing the disease usually belong to the streptococci group of bacteria. Mastitis has also a special significance in relation to public health as human beings may sometimes contract "septic sore throat" through the use of unpasteurized milk from affected cows.

CAUSE AND TRANSMISSION OF THE DISEASE

Acute Mastitis:

Acute cases of mastitis or garget may sometimes result from a variety of incidental causes such as bruises and injuries to the udder and teats; over-feeding and over-stocking of the udder at calving time; allowing freshly calved cows with distended and congested udders to lie on damp, cold cement stable floors, or to lie outdoors on cold, wet ground; chilling of the udder through exposure; irregular or incomplete milking. While these different causes may produce attacks of acute garget they are, after all, incidental, and it should always be definitely understood that the majority of cases are caused by bacterial invasion or germ infection of the udder resulting in cases of infectious mastitis, which sooner or later incline to become chronic and persistent cases.

Chronic Mastitis:

Chronic cases of mastitis are the most common and are invariably caused by bacterial invasion or germ infection of the udder. The disease germs belong usually to the streptococci group of bacteria of which the organism known as the "*Streptococcus mastitidis (agalactiæ)*" is the most frequent cause. Other bacteria, including "*Staphylococci*", also occasionally cause mastitis. Irrespective

of the exact type of bacterial infection present, the disease is always of the same nature and readily conveyed from cow to cow in the herd, chiefly by the hands of the milker.

Affected cows always harbour the disease germs in their udders and the hands of the milker serve as the medium to carry and transmit the infection to the other cows during the ordinary process of milking. The disease germs gain entrance to the udder by passing up the teat canal. The milking of cows with soiled hands favours the spread of the disease from one cow to another.

What is known as "*wet milking*" (milking with wet hands) always aids in spreading the infection from one cow to another.

Milking by the use of a milking machine will also spread the infection unless the teat cups and other parts of the machine are kept absolutely clean.

The improper use of milking tubes and teat dilators may also be harmful.

In any event the presence of a cow with infectious mastitis always results sooner or later in the widespread dissemination of udder trouble in a dairy herd.

As a rule the disease is first introduced by obtaining a cow with an infected udder, and the prevalence of the disease in some herds is continued by the purchase of new additions to maintain the milking capacity of the herd. The spread of the disease is also favoured by unsanitary stable conditions and insufficient bedding in the stalls.

SYMPTOMS AND COURSE OF THE DISEASE

The symptoms and course of mastitis vary according to the cause as well as the nature and extent of the inflammatory process in the udder.

Acute Mastitis:

Acute attacks of garget are usually manifested by the sudden development of udder trouble and systemic disturbance. When acutely inflamed the udder and teats become hot and tender, highly reddened and tensely swollen. In severe cases the cow is feverish and the temperature rises, the appetite is lessened and rumination or "chewing the cud" ceases for a time.

The milk flow is immediately lessened and changed in appearance, containing flakes and clots, or it may be mixed with the inflammatory exudate consisting of a yellowish serous fluid or have a reddish, bloody appearance.

Milking in these cases is difficult to perform as pressure on the teats increases the pain.

Where acute cases develop from incidental causes, the course of the disease may be favourable, and recovery may take place with proper treatment.

On the other hand, if septic infection is present pus may form, resulting in abscesses developing in the udder, or the udder may become gangrenous (putrefactive) which is evidenced by the skin covering the udder and teats becoming a purplish or greenish-black color and the skin may slough or peel off in places. In such cases the udder may be permanently damaged, resulting in the destruction of one or more quarters of the udder, with "blindness" of one or more of the teats, causing what are commonly known as "three-teated cows." While acute attacks of garget are liable to occur occasionally in high producing cows during the first month after calving, nevertheless they may occur at other times during the course of infectious chronic mastitis. After all, the chronic form of mastitis with or without acute attacks is the type of the disease which is most common.

Chronic Mastitis:

Whenever udder trouble develops in a herd it should be suspected as infectious and chronic mastitis. The symptoms are not always definite at the beginning as little or no constitutional disturbance is present except when acute attacks occur sometimes.

In the chronic form of mastitis the inflammation is persistent and gradually progresses, resulting sooner or later in diminished milk secretion. The milk is also altered in appearance, becoming thinner and changed in color. It does not keep well and frequently contains flakes and clots which are characteristic.

For a time only one of the quarters may be affected, but sooner or later the other quarters of the udder may also become involved. The inflammatory process tends to damage and destroy the milk secreting cells and tissues of the udder resulting in the formation of fibrous connective tissues (fibrosis) causing the affected parts to become firm and hardened (induration) and in some cases results in altering the general shape and appearance of the udder. Sometimes one of the first things to attract notice is the development of small, firm lumps (nodules) in the udder near the base of the teats. The nodules or lumps gradually increase in size and numbers until they can be easily felt as distinct indurations or hardened masses. The normal healthy udder is always pliable and elastic to the touch after milking is completed, and induration or hardening (fibrosis) of one or more quarters is indicative of mastitis.

In some cases abscesses develop in the udder, and pus can be squeezed out of one or other of the teats. The ultimate effect of chronic mastitis is to damage the udder, and where the damage is extensive one or more of the quarters may be permanently destroyed as far as milk secretion is concerned. The presence of chronic mastitis in a herd tends to spread from cow to cow chiefly by the hands of the milker, resulting in a marked and serious loss in milk production.

THE DETECTION AND CONTROL OF MASTITIS

Every case of mastitis should be considered as an infectious udder disease which is liable to spread in a herd unless controlled.

The early detection and separation of affected cows forms the basis for controlling the disease. For detecting cases of chronic infectious mastitis the following diagnostic methods and tests are employed:—

"Physical or Clinical Examination of the Udder": The attending veterinarian should make a careful clinical examination (palpation) of the udder of every cow on the premises.

The examination should be made immediately after the udder is milked empty, and any cow showing signs of udder trouble (induration) should be removed from the regular milking line.

The affected cows should then be grouped together according to the stage and extent of the disease in their udders so that the slightly affected cows will be milked first and the worst cases last. The sound cows must always be milked first before commencing to milk the affected ones, and the hands of the milker should be washed before milking each cow. This is important to prevent the further spread of infection from cow to cow by the hands of the milker. The clinical examination of the herd can be supplemented by the use of any of the other following methods of test or diagnostic aids:

"The Strip-cup Test": The strip-cup test consists essentially in the use of a porcelain or tin cup over the top of which is fitted a fine mesh screen or piece of black muslin cloth which serves as a sieve through which a little of the milk from each teat is squirted. Any clots or flakes present in the milk are caught in the meshes of the screen and can be readily observed. The presence of clots or flakes in freshly drawn milk is always an indication of garget and serves as a guide in detecting new cases.

"The Bromthymol Blue Test": This is known also as the thybromal test and is used to determine the alkalinity of the milk. The milk from mastitis cases is usually alkaline in reaction which this test will reveal. The test is of definite value when used by a skilled person together with a clinical examination of the udder of each cow and the use of the strip cup.

"Other Diagnostic Methods": There are a number of other reliable diagnostic methods used but they are of a technical nature requiring a knowledge of laboratory procedure and for that reason are not described in detail. They may be used when desired to make a more exacting examination of the milk and are termed respectively: The Chloride Test; The Rennet Test; The Catalase Test; The Hotis, and other Bacteriological Tests.

PREVENTION AND TREATMENT OF MASTITIS OR GARGET

The prevention and treatment of mastitis or garget in any form is always troublesome. Acute and chronic cases should be regarded as being essentially stages or forms of the same disease.

Acute Mastitis:

In the prevention and treatment of cases of acute mastitis incidental causes should be avoided or corrected in the general management of the herd. Towards this end cows at the time of calving should be kept in clean, comfortable, well-bedded stalls and protected against bruising of the udder; exposure and sudden chilling of the udder; over-feeding and over-stocking of the udder; incomplete and irregular milking. During acute attacks of garget the heat,

pain and swelling (congestion) may be reduced first by the use of cold applications to relieve the congestion, followed by repeatedly bathing or fomenting the udder with hot water. This is best done following each milking, and the milking should be done at frequent intervals, preferably every two hours so as to keep the udder in a relaxed condition. This is essential in the treatment of all cases to relieve the tension on the inflamed glandular tissues. Bathing of the udder can be done to better advantage by means of canvas soaking bags or suspensory bandages applied by using pieces of felt or woollen blankets cut to fit the udder with holes for the teats and kept in place by fastening up over the back. Another means of applying heat is to coat the surface of the udder over thickly with hot antiphlogistine paste. Other popular applications are warm poultices and liniments. As a rule poultices are hard to keep in place and may fail in that respect to accomplish their purpose. Strong irritating liniments should be avoided, but after the acute pain and heat is relieved the udder can be rubbed or massaged with a bland stimulating liniment or ointment such as iodine liniment or ointment. Generally speaking, acute attacks of mastitis are benefited by the foregoing line of treatment if intelligently carried out.

At the beginning of an acute attack a dose of physic can be given consisting of a pound of Epsom salts dissolved in two quarts of water and given carefully as a drench. The diet of the cow must be regulated for a time and should consist chiefly of bran mash three times a day to which may be added a tablespoonful of hyposulphate of soda. In the medicinal treatment of individual cases the following drugs have been used quite extensively. Half an ounce of potassium nitrate (saltpetre) added to the drinking water once or twice a day as may be desired. Formalin and spirits of turpentine given in half-ounce doses as a drench in a quart of milk two or three times a day. Recently the administration of Sulphanilamide is being advocated in doses of thirty grams dissolved in a little water and given as a drench two or three times a day for a period of from one to two weeks' time. However, the therapeutic value of this drug has not as yet been established to definitely recommend it as a cure for mastitis.

Vaccination has also been practiced but with doubtful results. Some also favour the drenching of the cow with a pint or two of its own milk from the affected quarters of the udder. Where abscess formation or gangrene of the udder develops, special antiseptic and surgical treatment is necessary which should be done by the veterinarian in attendance.

Chronic Mastitis:

This form of mastitis or garget should always be regarded as a serious, infectious udder disease which is liable to spread in a herd unless controlled. Unfortunately there is no specific vaccine or medicinal remedy available at the present time for the satisfactory prevention and cure of the disease. The control of infectious mastitis is based on the detection and separation of affected cows, and the building up of a sound herd as conditions permit. Whenever this udder disease appears in a herd the owner will be serving his own best interests by securing the services of a veterinarian for the purpose of detecting all of the

affected cows and applying control measures and individual treatment as may be indicated. The first and essential thing to do is to have a careful clinical examination made by the attending veterinarian of the udder of every cow in the herd; supplemented by the use of the strip-cup test and the bromthymol blue test or any other of the recognized methods of test. Following this every cow showing signs of udder trouble should be removed from the regular milking line. The cows should then be arranged in two groups comprising the group with sound udders and the group with affected udders. The group with sound udders must always be milked first, and the milker's hands should be washed clean before milking each cow. This is important in order to prevent or limit the further spread of infection. The cows with affected udders should then be grouped separately according to the stage and extent of the disease in their udders. The milking of this group should be arranged so that the slightly affected cases will be milked first and the worst cases last. The affected cows should then be kept under observation and when considered desirable can be treated individually as already described, namely, by frequent milking to keep the udder relaxed; by hot fomentations or bathing the udder; by massaging or hand rubbing the udder with iodine liniment or ointment; by regulating the diet to lessen milk secretion, and by medicinal treatment. Cows with badly damaged udders should be removed from the herd, together with those which do not respond to treatment within a reasonable time. As in all other infectious diseases the aim should be to eliminate all of the affected cows that may act as carriers and spreaders of infection and to ultimately build up and develop a sound herd from the healthy cows and their offspring. While this naturally will take time it should, however, be clearly understood that as yet no other satisfactory plan is available for controlling chronic mastitis in affected herds. The udders and flanks of all milking cows must be kept clean, which can be done by regular brushing and washing from time to time. In milking affected cows care should be taken that none of the milk is spilled on the bedding. The stalls occupied by milking cows should be periodically disinfected, and must be kept clean and well bedded. In the event of any new cows being purchased, they should not be admitted to a clean herd until they have been clinically examined and tested and found to be free from mastitis. In order to protect public health the milk from mastitis affected herds should not be used for human consumption unless it is properly pasteurized.

SUMMARY

The Systematic Control of Mastitis:

- (a) By arranging the cows in the milking line so that the affected and non-affected animals are milked separately.
- (b) By the adoption of precautionary measures to limit the further spread of the disease, including sanitation and hygiene.
- (c) By elimination of the affected animals from the herd as conditions permit.
- (d) By developing a mastitis-free herd from the offspring, and by replacement or additions of non-affected cows.

